Addendum for page vii., vol. III., Transactions.

LOUIS H. LAUDY.

Photography—Past and Present (May 5, 1884), *without abstract*.... 100

W. A. Kellerman.

A-C- 75

TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

October 1, 1888.

REGULAR BUSINESS MEETING.

The First Vice-President, PROF. O. P. HUBBARD, in the chair, and DR. H. C. BOLTON, Secretary *pro tem.*

The Council not having held a full meeting, no report was presented.

PROF. D. S. MARTIN announced to the Academy the resignation of the office of Recording Secretary by PROF. H. LEROY FAIRCHILD, in consequence of his acceptance of the chair of Geology in Rochester University, and spoke of the loss thus sustained by the Society.

He also reported for the Publication Committee, on the work done during the summer, including the issue of the remaining parts of Transactions, vol. VII. (to June), with index, etc., complete; the printing and speedy issue of the Annals, vol. IV., Nos. 8 and 9, and also of the long-desired index to the old Proceedings, of both series (I. and II.). This work had almost all been done by Prof. Fairchild. He had himself also prepared and sent to press the index, etc., for vol. III. of the Annals, some time delayed.

DR. N. L. BRITTON spoke of the fact, that all the Academy's publications were now brought up to date, as a matter for congratulation.

THE CHAIRMAN, referring to the mastodon tooth mentioned in the minutes of the last meeting, stated that further study showed it to be not a milk-tooth, but one of the sixth series.

PROF. MARTIN announced the death, during the past summer, of MR. ROBERT DINWIDDIE, for many years Corresponding Secretary of the Society, under its old organization as the "Lyceum."

He also read a communication from MR. GEORGE F. KUNZ, as follows :—

MR. KUNZ announces that Mr. J. A. D. Stephenson of Statesville, North Carolina, who first called the attention of Northern mineralogists, in 1875, to the green beryls in North Carolina, has kindly loaned him a crystal weighing 25.4 oz., of dark green beryl, part of which would furnish gems of some size. It was found on the 12th of January, 1888, by a farmer, in plowing near Little Robinet's Store and Little River Church, near Russell Gap Road, Alexander Co., N. C. (A photograph of the crystal was exhibited.) This locality is about ten miles from the Stony Point emerald mine, and twelve miles from Miller Farm, where emeralds also occur, and is the largest beryl affording gems that has been found in the State.

Mr. Kunz announces the following minerals as new from Manhattan Island:—Seams of carbonate of lime satin spar, one-third of an inch thick and five inches square, occurring at the Ship Canal, Kingsbridge ; also from the same locality, pyrrhotite in fine distinct crystals implanted on and enclosed in translucent and transparent scalenohedral calcite crystals.

From 86th Street and Fourth Avenue, translucent oligoclase, penetrated by blades of black hornblende ; these specimens, when polished, resemble the hornblende in quartz from Cumberland, R. I. :—dark leek-green prehnite, in seams one-third of an inch thick and five inches across, also in isolated crystals on gneiss:—siderite in very distinct simple rhombohedral crystals with curved faces, implanted on mica schist.

In a mica schist on the site of the Old Men's Home, Fort George, staurolite in brilliant dark brown doubly-terminated crystals, one-third of an inch long.

Ophiolite and serpentine, the result of an alteration from pyroxene, from the excavations at Aqueduct shaft No. 26, 180th St. and Tenth avenue.

Also, from Colorado, turquoise resembling the Los Cerrillos variety, the color a deeper and better blue, occurring in veins of feldspathic granite, from the Holy Cross Mining District, thirty miles from Leadville.

DR. H. C. BOLTON gave some account of his visits during the summer to a number of scientific libraries in Austria, Germany, France, and England. In several of these institutions, he had found an extraordinary lack of facilities for research, so much so as to render them absolutely useless to the original investigator. In others, however, he had been gratified to find better ideas and methods prevailing; but these were in the minority.

DR. N. L. BRITTON described briefly his summer spent in botanical studies in the Herbarium of the Kew Gardens. He had taken over the undetermined portions of DR. RUSBY'S collections from Brazil and Bolivia, for comparison and identification so far as possible. As a result, he found that Dr. Rusby had secured between two and three hundred species new to science. These would soon be described and published.

DR. FRANZ BOAS stated that he had visited the region of Queen Charlotte Island, and the interior of British Columbia, in the prosecution of ethnological studies. He was led to believe that the Tlingit and Haida tribes belong to one and the same stock, but not the Tsimshian, nor the Southern tribes, which form yet another group. The folk-lore shows the close relation of the first and second; a study of the legends proves that to some extent even the Sioux folk-lore reached and influenced the tribes of the Pacific coast.

THE CHAIRMAN referred to a search for oil undertaken in the Triassic basin of Southbury, Conn., and discussed somewhat the geology of that region.

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THE CHAIRMAN referred to a search for oil undertaken in the Triassic basin of Southbury, Conn., and discussed somewhat the geology of that region.

PROF. J. J. STEVENSON and DR. BRITTON remarked further on the same subject.

October 8, 1888.

The First Vice-President, PROF. O. P. HUBBARD, in the chair.

Twenty-two persons present.

The letter of PROF. H. LEROY FAIRCHILD, addressed to the Council, resigning the office of Recording Secretary, in consequence of removal from the city, was read to the meeting by his successor in that office, DR. H. C. BOLTON.

PROF. D. S. MARTIN spoke of the admirable manner in which Prof. Fairchild had discharged the often onerous duties of his position, and the obligations of the Academy to him for the services so ably rendered.

It was voted to embody these sentiments in the records of the Society, and to send a copy thereof to Prof. Fairchild.

Several gifts of books were reported. MRS. ANNA RANDALL DIEHL presented her volume "Two Thousand Words not in Webster's Dictionary;" and DR. BOLTON presented two small but remarkable pamphlets, which he had procured as duplicates from the Librarian of the Museum of the Jardin des Plantes at Paris. These were, (1) a leaflet of eight pages by C. S. Rafinesque, dated Philadelphia, 1838, and containing a list of all his works, both actual and prospective, and (2) an Address by Doctor Samuel L. Mitchill, the first President of the Lyceum, delivered to the Medical Staff of New York, 1820.

The Librarian, DR. N. L. BRITTON, spoke of the great interest attaching to these additions to the library.

DR. FRANZ BOAS presented the paper of the evening, exhibiting and describing a series of Indian skulls from British Columbia, with further illustration in the form of drawings and photographs. These were a selection from a large number of skulls collected by him in his recent tour in that region, and had been procured with special reference both to natural and artificial

peculiarities among the various tribes, particularly the process of flattening the cranium by pressure. He described the cradle, and the cushions and boards used for compressing the head of the infant. He showed that on the North Pacific Coast various types of deformed skulls occur. In a skull from the southern part of Vancouver Island, the frontal and occipital bones were perfectly flat, and a marked depression was found immediately behind the coronal suture. On account of the strong antero-posterior pressure, these skulls are very short, but this is compensated by their greater breadth. The width-length index of these deformed skulls ranges from 97 to 102. Another group of skulls, collected among a tribe which belongs to the same linguistic stock as the former, are also deformed; but they have rounded occipital and frontal bones. The occipital flattening extends beyond the Lambda. The parietal bones have enormous eminences which compensate for the retarded growth in length. A great number of these skulls have Wormian bones. Among sixty deformed skulls, two were found in which the frontal suture remained open at an advanced age. In one there is a synostosis of the parietal bones. The last cranium is nevertheless hyper-brachycephalic. Many skulls of this class are very asymmetric. It is remarkable that in almost all asymmetric crania the left side is larger than the right. This is probably due to the way in which the children lie in the cradle. Skulls found in a number of ancient cairns and in shell-heaps, prove that the inhabitants at that period belonged to the same race and deformed their heads in the same way as the present tribes do. While the skulls which had been described so far belonged to tribes of Salish lineage, the next type belonged to the Kwakiutl. The heads are conical, the vertex lies considerably behind the bregma. The occiput of these skulls is somewhat flattened. It seems that undeformed crania of the Kwakiutl and Salish belong to two separate types, the former being much more dolichocephalic and hypsicephalic. The Kwakiutl tribes on the northern half of Vancouver Island deform principally the heads of female children. The Tsimshian and Haida do not deform the heads of their children. As these people are in the habit of burning their dead, it is only by chance that graves are met with. The

skulls are very prognathic, and the incisors of the women are artificially ground down so as to form a regular curve.

The subject elicited an active discussion. MRS. RANDALL-DIEHL inquired regarding the object of the practice of skull-flattening; and DR. BRITTON, as to whether the size of the brain-cavity is modified thereby.

DR. BOAS replied that similar deformations of various parts of the body are practised all over the world among savage and semi-savage peoples. As to the brain-cavity, he doubted whether the capacity was affected,—probably only the form; but it is hard to decide.

DR. BENJAMIN LORD and PROF. MARTIN made inquiries and remarks as to the teeth, the latter observing that the wearing-down of the molars in savage and prehistoric skulls is frequently attributed to the use of crude and coarse food, hard broken grain, etc.

DR. BOAS replied that in this instance the theory alluded to is not borne out, the principal food of these tribes being boiled salmon; but he referred to the Eskimo habit, especially among the women, of chewing leather and skins, to render them pliable, in the absence of any process of tanning.

PROF. HUBBARD inquired as to the occurrence of normal skulls; and also remarked upon the great collections and extensive studies in craniology of the late Prof. Morton.

DR. BOAS stated that he had found a few skulls that were not deformed, but could not be sure that they were those of full-blooded Indians.

October 15, 1888.

STATED MEETING.

President NEWBERRY in the chair.

Forty-two persons present.

The resolutions voted at the last meeting, in regard to the resignation of Recording Secretary Fairchild, were presented and read by PROF. D. S. MARTIN, as follows:

Whereas, the Academy has learned, with much regret, of the resignation of PROF. HERMAN LEROY FAIRCHILD from the office of Recording Secretary, in which position he has so ably served the society for several years past, therefore be it

Resolved, that the Academy desires hereby to place on record its deep sense of the uniform courtesy, skill and fidelity with which Prof. Fairchild has discharged the important and often exacting duties connected with his office, and also to express the great obligation which the Academy feels to him, not only for much of the interest and success of its meetings during recent years, but for important elements of permanent growth and strength.

Resolved, that the members and officers of the Academy congratulate Prof. Fairchild on the interesting position that opens before him in the University of Rochester; and that while they feel his removal as a personal loss, their heartiest good-wishes will follow him in his new work for science and education.

The resolutions were unanimously approved.

MR. GEORGE F. KUNZ exhibited a specimen of sheet gold on turquoise, from Los Cerrillos, New Mexico, and also the large crystal of aquamarine from North Carolina, mentioned at the meeting of October 1st.

MR. KUNZ announced the death, since the last meeting, of MR. BENJAMIN B. CHAMBERLIN, long one of the most valued members of the Academy.

PROF. MARTIN spoke in regard to the loss which the society had sustained in the death of so active and faithful a member. His varied attainments in science, his zeal and success as a local mineralogist, his constant interest in the Academy and presence at its meetings—whither his new acquisitions were always brought, for the pleasure and profit of the members—these all made his loss peculiarly felt. It is matter for much congratulation, however, that two important departments of his work had been recently completed under his own supervision. His "Catalogue of the Minerals of New York Island" had been revised and published in the Academy's TRANSACTIONS, last spring; and during the past summer his entire local collection

had been unpacked and deposited in the fire-proof building of the American Museum of Natural History, where it is hoped that it may remain permanently, as the property of the New York Mineralogical Club, which will endeavor to purchase it.

MR. W. E. HIDDEN spoke in a similar strain, referring especially to his personal indebtedness to Mr. Chamberlin for stimulating and guiding his own interest in mineralogy, when a youthful beginner in the study.

THE PRESIDENT confirmed the estimate placed on Mr. Chamberlin as a member and a scientist, and dwelt further on the beauty of his private character. Rarely had he known a man so simple, so upright, so kindly, and so pure. From such as he, it is hard to part; and the world is richer for their lives, and poorer for their loss.

MR. HIDDEN spoke regarding the large aquamarine exhibited by Mr. Kunz, and stated that the locality was highly promising.

He also made a preliminary announcement of two new mineral species—Auerlite, a silico-phosphate of thorium, and sulphohalite, a combination of chloride and sulphate of sodium. The former, which he had named for Dr. Auer von Welsbach, occurs in minute orange-red tetragonal crystals, with density 4.42 to 4.76, and is a hydrous silicate of thorium, with phosphoric acid replacing part of the silica. It has been found only in Henderson County, N. C., at the Freeman mine, on Green River, and at a point three miles southwest. In both cases it occurs in the débris of crystalline rocks, closely associated with zircon crystals, and often implanted upon them. As it was discovered in connection with the mining of zircons, for use in the Welsbach process for electric lighting, it seemed appropriate to give it the name of the inventor of that process.

The chemical interest of this species is very great. There is nothing to indicate mixture of two minerals; and it seems to be not only a thorium phosphate, known for the first time in nature, but also an example of the very peculiar replacement of silica in part by phosphoric acid. The formula seems to be

$$ThO_2 \left\{ \begin{matrix} SiO_2 \\ \frac{1}{3}P_2O_5 \end{matrix} \right\} 2H_2O$$

the thoria approximating 70 per cent, water 10, and silica and phosphoric acid each 7½ to 8, from several analyses.

Sulphohalite is proposed as the name for a new mineral from Borax Lake, Cal., associated with hanksite, or implanted upon it. The crystals are isometric, in sharp and perfect rhombic dodecahedrons, transparent, and faintly tinted with greenish-yellow. Their size varies from .2 to nearly an inch in diameter; hardness, 3.5; sp. gr. (estimated in naphtha), 2.489. Analysis gives the formula

$$3Na_2SO_4,2NaCl.$$

But three crystals are yet known, two in the Bement cabinet in Philadelphia, and a third, used in part in the present investigation. It is the second species known in mineralogy having the composition of a sulphato-chloride, the other being Connellite, from Cornwall, England, in which the base is copper.

The analyses of both these remarkable minerals have been made by MR. JAMES B. MACKINTOSH; and fuller particulars are to be given in the *Amer. Jour. Science* for December, 1888.

Dr. BOLTON announced the decease of a corresponding member of the Academy, PROF. RACHEL L. BODLEY, Dean of the Women's Medical College of Pennsylvania. He spoke of the high abilities and excellent work of Dr. Bodley, and of the important part that she had borne, in 1874, in the plans that led to the convention of American chemists and the Priestley Centennial, at Northumberland, Penn.

THE PRESIDENT spoke of his observations during the past summer, first in Colorado, and then abroad, at the International Congress of Geologists in London, and after that in Belgium, visiting some very remarkable palæontological collections and museums at Brussels, Liège, and Aix-la-Chapelle. Of these, he would speak more fully hereafter.

The paper of the evening was then read:—

THE TRUE CAUSE OF SONOROUSNESS IN SAND.

By ALEXIS A. JULIEN and H. CARRINGTON BOLTON.

Dr. Julien, in the course of his reading, called upon the Secretary to open and read a sealed packet deposited with the Society on September 27th, 1888.

The paper was as follows:

NEW YORK, Sept. 25th, 1888.

To the New York Academy of Sciences:

The undersigned would respectfully announce to the Academy that they have further pursued the investigation already reported, on the subject of the sonorous sand found on singing beaches and deserts, and have determined the true cause of the sonorous property to be connected with thin pellicles or films of air, or of gases thence derived, deposited and condensed upon the surface of the sand-grains during gradual evaporation, after wetting by the sea, lakes, or rains. By virtue of these films, the sand-grains become separated by elastic cushions of condensed gases, capable of considerable vibration, whose thickness we have approximately determined. The extent of the vibration, and the amount and tone of the sound thereby produced, after any quick disturbance of the sand, we also find to be largely dependent upon the forms, structures, and surfaces of the sand-grains, and especially upon their purity or freedom from fine silt or dust.

The conveyance of the silt of rivers and seas, and its deposit, we find to be also connected with its support by attached condensed gas films, and with their removal.

The full statement of our observations and views is reserved for a future communication.

Very respectfully submitted,

H. CARRINGTON BOLTON,
ALEXIS A. JULIEN.

The reading of the paper was then resumed and completed by DR. JULIEN.

Specimens of the sand were then exhibited and tested before the audience. A package filled at Rockaway Beach, four years before, gave sounds distinctly heard through the room, upon being strongly and quickly shaken. A jar of sand, also from Rockaway, filled and closed on September 5th, 1883, was opened for the first time, and uttered a distinct high note when rubbed between the hands. DR. BOLTON had stated, before testing these samples, that it was entirely doubtful whether they had

retained their sonorous property for so long a time, and that even the faintest manifestation would be an interesting success. Both samples were audible throughout the whole audience.

October 22, 1888.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Fifty-four persons present.

DR. NEWBERRY exhibited remarkably fine specimens of stromeyerite and native silver, from the Silver King Mine, Arizona.

He then gave the paper of the evening, entitled:—

"THE GREAT MUSEUMS OF EUROPE, NOTES ON THEIR CONTENTS AND ARRANGEMENT,—INCLUDING THOSE OF EDINBURGH, LONDON (THE OLD BRITISH MUSEUM, SOUTH KENSINGTON AND JERMYN STREET), BRUSSELS, LIEGE, PARIS, BERLIN, MUNICH, AND DRESDEN."

The paper was largely occupied with an account of the construction and arrangement of the South Kensington Museum, and the disposition of the great amount of palæontological material, new and old, now gathered there; also of the collections of Devonian fishes and plants from the "yellow sandstone," in the museum at Edinburgh; and especially of the extensive and wonderful series of Dinosaurs now mounted at Brussels, far surpassing any display of these peculiarly interesting forms to be seen elsewhere in the world.

October 29, 1888.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Forty persons present.

MR. G. F. KUNZ sent a communication, read by PROF. MARTIN, on the occurrence of Bertrandite at Stoneham, Me., and Mount Antero, Col., and other minerals.

Implanted on the damourite taken out of the pockets containing herderite at Stoneham, Me., described by Mr. W. E. Hidden (*Amer. Jour. Science*, February, 1886), I noticed some small, flat crystals, less than one-fourth of an inch long. These, after having had for some time, I at last suspected to be bertrandite, and through the kindness of Dr. S. L. Penfield this conjecture has been verified. They are especially interesting, because they show an entirely new crystalline development, being hemimorphic in the direction of the vertical axis, as in struvite and calamine, according to Dr. Penfield. This hemimorphism explains also the curious rounded, one-sided development of the Mt. Antero crystals. The specific gravity is 2.591.

Among a lot of Mt. Antero (Colorado) minerals recently sent me were a few crystals of bertrandite, of the largest size yet obtained, measuring 27 mm. in length, and 6 mm. in width. These were implanted on blue beryls, some over two inches long and three-fifths of an inch in diameter, curiously eaten out and often coated with bertrandite and phenacite; both these minerals evidently the result of the decomposition of the beryl. Some of the new prismatic phenacites in the same lot were the largest yet found, one measuring 26 mm. in width, and 20 mm. in length, doubly terminated with faces of the simple rhombohedron. The same locality yields beautiful orthoclase in simple Baveno and Carlsbad twins, in color and form identical with the finest crystals from Baveno, Italy, from one and one-half to two and one-half inches in length. These specimens were obtained near the upper part of Mt. Antero, at an altitude above 12,000 feet—a locality that is generally concealed by snow, and only accessible for a short time in the summer.

From San Luis Park, Colorado, have been received some curious amethyst crystals, light colored, very long, and with fluid-cavities arranged conformably to enclosed pyramidal planes, which thus appear, as in "phantom crystals." A succession of pyramidal faces gives the great length, and is terminated trihedrally.

Arizona has now afforded us, in addition to the remarkable azurite and malachite, some of the finest known crystals of cuprite. They are of two forms; the first are large cubes, measuring from 10 mm. to 25 mm. in width, occurring as group-

ings and bunchings on strings of native copper. These are generally altered to a softer variety of cuprite, but more often coated with malachite, as in the crystals from Chessy, France.

The other form, kindly sent me by Mr. T. A. Heistand, from the collection of Clarence S. Bement, occurs in cavities of cuprite, sometimes as single crystals and again covering surfaces several millimetres across. These are often most brilliant ruby-red in color, and as splendent as any known mineral. In size, they vary from 1 mm. to 6 mm. in diameter, and, as the measurements show, are remarkable for their sharpness of angles and polish of faces.

The locality given for the topaz and phenacites in the *Amer. Jour. Science*, September number, as near Stoneham, Me., is in reality near the Maine State line, in New Hampshire, in the town of North Chatham, on the top of Bald Mountain.

On motion of MR. W. H. J. SIEBERG, the President appointed a committee to prepare resolutions in memory of the late MR. B. B. CHAMBERLIN, naming Mr. Sieberg, Prof. Martin, and Mr. Kunz as the members.

PROF. JOHN K. REES then read the paper of the evening, entitled:

ASTRONOMICAL PROGRESS AND DISCOVERY FOR THE YEAR, OCTOBER 1ST, 1887, TO OCTOBER 1ST, 1888.[1]

The subject was treated under the following heads:

Instruments.—Mention was made of the new personal-equation machine of the Royal Observatory at Greenwich, England, of Sir Howard Grubb's new arrangement of electrical control for driving-clocks of equatorials; of the electric illumination of Dr. Gill's heliometer; of Gothard's apparatus for registering the readings of the wedge photometer without disturbing the eye; and of Repsold's automatic method of recording transits of stars.

Observations.—The work of the U. S. Naval Observatory, Harvard College, Yale College, and the Lick Observatory, were briefly alluded to. Especial attention was paid to the work at Yale, carried on by Dr. Elkin. The work done by some of the foreign observatories was also stated with brevity.

[1] This paper appears in full in Appleton's *Annual Cyclopædia* for 1888.

Astronomical Photography.—Mention was made of Prof. Pritchard's work at Oxford on the determination of the parallaxes of stars; also of the photographs of M. M. Henry and Mr. Roberts.

Photographic Chart of the Heavens.—Dr. Gill's progress was commented on.

Solar Parallax.—The results from the American photographs of the last transit of Venus, as given by Prof. Harkness, of the U. S. Naval Observatory, were stated.

Eclipses of the Moon.—The value to science of the total lunar eclipses occurring in January and July was explained.

Asteroids.—The year's record showed eight new asteroids.

Comets.—Six comets were discovered between October 1st, 1887, and November 1st, 1888.

Double and Binary Stars.—The orbits of four binaries were exhibited.

The Sun.—The changes in the solar surface were alluded to.

Saturn, Mars, and Jupiter.—Recent observations on rings, canals, and red spot were stated.

The Chief Meteor Showers were mentioned.

Meteorites.—Prof. Newton's recent paper was quoted, also Lockyer's "Meteoritic Theory."

Solar Physics.—Allusion was made to the work at Harvard College on the investigation of the coincidences in the solar spectrum lines with terrestrial spectrum lines; and to Crew's determination of the rotation period of the sun by the spectroscope.

Spectroscopy.—Prof. Grünwald's theory was quoted; Mr. Louis Bell's determination of wave-lengths was dwelt upon; and also the work of determining the motions of stars in the line of sight.

The Constant of Observations.—Professor A. Hall's determination was given.

Resisting Medium.—Recent investigations were mentioned.

Catalogues.—A list of important catalogues of stars, nebulæ, etc., was read.

The paper closed with a very brief mention of some of the new books on astronomy.

November 5, 1888.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Forty-one persons present.

The report of the Council was read, comprising recommendations as follows:

I. The payment of certain bills.

II. The holding of a social reception, for the members and their ladies, on the evening of the next meeting, November 12th. The desirability of some such occasions was judged to be apparent; and the parlors of Rutgers Female College having been offered the Academy for any such purpose, it was recommended that the reception be held there, and that

III. An appropriation not to exceed $100 be made for the expenses of the entertainment.

The recommendations of the Council were unanimously voted; and the Academy also approved the nomination of PROF. D. S. MARTIN, DR. H. C. BOLTON, and DR. N. L. BRITTON as a Committee of Arrangements for the reception.

DR. OLIVER P. HUBBARD related an early case of anæsthesia that occurred under his personal observation on November 5th, 1821, at 9 o'clock P.M., just sixty-seven years ago, *to the hour*, when he was speaking.

A German druggist, Dr. Stockman, of Utica, N. Y., gave at Rome, on the evenings of November 5th, 6th, and 7th, an exhibition of the effects produced by the inhalation of nitrous oxide.

On the 5th, the exhibition was closed "because there was no more gas," and after some time the doctor went into the room where his gasometer was, and found a young man lying on the floor beside it, completely insensible.

There was, of course, much alarm. Two men, one under each arm, raised him up and brought him out into the ball-room, and they held him, supposing he was near death.

No means were used to restore him. After a good while, there was a slight motion of his feet, which gradually increased and became rapid, until they played like drumsticks, and he went off into a vigorous dancing till he became exhausted and recovered his consciousness, without any ill effects.

He had stealthily found the gasometer and inhaled the gas *ad libitum*, and fallen off.

This is believed to be the *first case of anæsthesia by this agent on record.*

It occurred about midway in time between Sir Humphrey Davy's publication of his experiments in 1799 and those made by Dr. Wells in 1844, in dentistry, at Hartford, Conn.

A full account was read at the annual meeting of the New York State Medical Association, October 9th, 1888.

DR. N. L. BRITTON stated that MR. C. HENRY KING, of Philadelphia, announces that the bed of diatomaceous earth occurring in Virginia, and well known as the "Richmond infusorial earth," had been found, at a depth of 406 feet, in artesian wells at Atlantic City, N. J.

The announcement was received with much interest, and called forth remarks from Prof. Martin, Dr. Britton, Dr. Hubbard, and the President.

A communication was read from MR. G. F. KUNZ, regarding minerals recently found in the trap of New Jersey, as follows:

During some excavations which have been carried on during the last year by the Pennsylvania R. R. at Mt. Pleasant, Bergen Hill, N. J., a few very interesting minerals have been collected through the perseverance and energy of Mr. Frederick Kato, who has kindly placed them in my hands. Among these are nodules of chalcedony in grayish hydrophane, forming veins

about two inches thick, the latter being perhaps an alteration from the chalcedony. This hydrophane is very hygroscopic, and when a small fragment is put into water, bubbles rise from it for fully five minutes. In several instances, associated with these, were small pieces of transparent *fire opal*, slightly yellow-tinted, in regularly shaped masses, measuring nearly one inch by one-third of an inch. This opal, however, shows no prismatic colors.

Blue and white barite, in crystals measuring nearly one inch on the prism faces, and coated with stilbite, were also found; likewise a beautiful crystal of sphalerite, measuring one inch in diameter, and what are perhaps the finest specimens of diabantite yet obtained, in fibrous seams, bluish-black in color, and, when broken, strikingly resembling the unaltered crocidolite from Orange River, South Africa.

The paper of the evening was then read by DR. H. CARRINGTON BOLTON, on

THE LIKENESSES OF JOSEPH PRIESTLEY, IN OIL, IN INK, IN MARBLE, AND IN METAL.

The paper was illustrated with a collection of portraits, books, medals, apparatus, and other memorials of Priestley, exhibited jointly by the author and MR. CONYERS BUTTON, of Philadelphia.

(Abstract.)

The speaker prefaced his paper by a brief sketch of the active life of Joseph Priestley, referring to his discoveries in chemistry, his theological and literary publications, his trials at the Birmingham riots, his withdrawal to the United States, and his subsequent quiet life. He quoted from Corry's "Life of Priestley" (exhibited) a passage describing the personal traits and appearance of the chemist.

The speaker then described the numerous likenesses of Priestley, taking up first the known oil-paintings and the engravings made from them; of each he gave the history, so far as known, and its present ownership. He next spoke of the statues in Oxford and in Cambridge, of the Wedgwood medallions, and of the various medals and tokens which bore Priestley's features. He referred briefly to the memorials preserved in the Royal Society, London; the Reference Library, Birmingham; in the hands of

private collectors abroad and at home; and to the large collection of chemical, electrical, and philosophical apparatus presented by his descendants to the Smithsonian Institution.

The portraits described were the following; those marked by an asterisk were exhibited:

1. The Leeds portrait, about 1763.
*2. Photo. of the same.
3. The Vaughan portrait in Cambridge, Mass.
*4. Photo. of the same.
5. The Opie portrait in London.
*6. Photo. of the same.
*7. Caldwell's engraving of the same (1801).
8. Hazlitt's portrait (1788).
*9. Nutter's engraving of the same (1789).
10. Artand's portrait (1793).
*11. Holloway's engraving of the same.
*12. Engraving after Artand in Lavater.
13. The Fuseli portrait (1783) in London.
14. Turner's engraving of the same.
15. Wentworth's engraving after Fuseli.
16. Photo. of the Fuseli portrait.
17. Millar's portrait (1789) in London.
18. Holland's portrait.
19. The Stuart portrait (1794?).
20–22. Three large copies of the same.
23–26. Four small copies of the same.
*27. Partridge's engraving after Stuart.
*28. Holl's engraving after Stuart (1833).
*29. Engraving in *Biographical Magazine* (1794).
*30. Cook's engraving after Stuart.
*31. Copy of the above publ. in New York (1874).
*32. Engraving with Blair and others.
33. Engraving with a light green oval.
34. Copy of 28 in Smiles', Boulton & Watt.
35. The Mansell portrait (artist unknown).
36. Peale's portrait in N. Y. Historical Society.
*37. Photo. of the same.
38. The Wistar portrait in Philadelphia.
*39. Photo. of the same.
40. The Button portrait in Philadelphia.
*41. Photo. of the same.
*42. Reich's vignette after the Button portrait.
*43. The Sharples portrait.
*44. Autotype of the same.
45. Mrs. Sharples' portrait in pastels.

46–48. Wedgwood medallions.
49. Pearson's engraving of the same.
50. Wedgwood's life-size bust of Priestley.
51. Plaster copies of the same.
*52. Engraving after Wedgwood in *Westminster Magazine.*
*53. Engraving in *European Magazine* by Bromley.
*54. Angus' engraving after Wedgwood.
55. G. Murray's engraving.
*56. E. Mackenzie's engraving (1805).
*57. Fr. Leopold's engraving (1807).
*58. Tardieu's engraving.
*59. Hopwood's engraving.
*60. Engraving in Corry's "Life of Priestley."
61. Alex. Hogg's engraving.
62. William Darton's engraving (1822).
63. Kendrick's silhouette (1854).
*64. Grope's silhouette.
*65. D. Eaton's engraving.
66. Crayon drawing executed in America.
67. Same as 65 reduced in size and in oval.
*68. Lithograph of 67, New York, 1882.
*69. Caricature in *Attic Miscellany*, July, 1791.
70 and 71. Colored caricatures in Timmins' collection.
72. Caricature, "The Mystical Philosopher," 1796.
73. Halliday's bust.
74. Stephens' statue in Oxford.
*75. Photo. of the same.
76. Williamson's statue in Birmingham.
*77. Stodart's engraving of the same.
*78. French copy of the latter.
79. Rowe's profile on tablet, Birmingham.
80. Medallion in terra cotta, Budapest.
81. Brass medallion with profile.
82. Phipson's medal in bronze.
83. The same in silver.
84. Hancock's medal (1783).
85. Copper token with "Citizen of the World."
86. Halliday's bronze medal.
87. The same in silver.
88. Plaster bust in Am. Philos. Society.
89. Plaster medallion at same Society.
90. Profile in black leather.
91. Papier-maché copy of Wedgwood medallion.
92. Beni's plaster bust.
93. William Waite's medallion portrait.
94. Locket portrait (Toulmin Smith).

96. Locket portrait (Swann Harrell).
97. Engraving showing destruction of Priestley's dwelling at Fair Hill, July, 1791.

At the close of the paper, PROFESSOR BOLTON and MR. BUTTON exhibited many of the scientific treatises and pamphlets published by Priestley; facsimiles of some letters; a silver facsimile of a wax impression of his seal; volumes on the riots of Birmingham, with views of the destruction accomplished; several bronze and silver medals; the Wedgwood medallion; a brass medallion; one of papier maché; a seal bearing Priestley's profile; and a few pieces of Priestley's glass apparatus. Also, a memorial scrap-book, containing autograph letters, newspaper cuttings, and photographs taken at Northumberland in 1874.

November 12, 1888.

The stated meeting took the form of a social reception, as voted at the last meeting, and was held in the parlors of Rutgers Female College, in West 55th street. About 130 persons were present—members of the Academy, with ladies, and some other invited guests. The invitations were issued in the name of the Council, and the members of the Council took part by turns in receiving, assisted by the President of the College, REV. DR. SAMSON, and the Lady Principal, MRS. E. S. WEST.

DR. A. A. JULIEN exhibited, under four microscopes, low forms of vegetable and animal life, illustrating motion; and DR. H. C. BOLTON displayed his collection of about four hundred engraved portraits of men of science, many of which are old, rare and remarkable.

A collation was served, and the entertainment was continued till a late hour.

November 19, 1888.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-two persons present.

On motion of Vice-President HUBBARD, a vote of thanks was

extended to the President and Faculty of Rutgers Female College, for their courtesy in granting the use of their parlors for the reception.

THE PRESIDENT spoke of the arrangements made by the National Academy of Sciences for the meeting of the International Geological Congress, to be held at Philadelphia, in 1891.

PROF. MARTIN exhibited, in behalf of MR. G. F. KUNZ, two peculiar specimens of mingled feldspar and dolomite, recently found by MR. WM. NIVEN, in the cutting for the ship canal at Kingsbridge. The feldspar is the fetid variety, known as necronite, and has been reported before as found at Thompson's quarries in the same neighborhood. The dolomite, however, is new to the island; as it, like the feldspar, is fetid. On the slightest rubbing of two pieces together, a strong odor is developed, which is compared by some to sulphuretted hydrogen, and by others to arsenic vapor.

MR. KUNZ also announced that among the yellow titanites found by MR. NIVEN on the site for the Old Men's Home, at Fort George, N. Y. City, was one piece which MR. NIVEN had had cut into a small gem, weighing about $\frac{1}{8}$ karat, and quite brilliant, although hardly equal to the same material from Tavetschthal, Switzerland.

PROF. HUBBARD exhibited a fine polished specimen of rutile in quartz, from a boulder of unknown origin found many years ago in New Hampshire.

DR. FRANZ BOAS read the paper of the evening, entitled:

THE CONSTRUCTION OF THE MAP OF THE UNITED STATES.

The subject was treated at some length, especially in relation to the difficulties and necessary inaccuracies caused by the representation of a curved surface upon a plane, and the various methods employed to obviate those difficulties and reduce the deviations from nature as far as possible to a minimum.

November 26, 1888.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-eight persons present.

DR. J. J. FRIEDRICH exhibited some interesting minerals from California, and made the following remarks thereon :

I wish to present a peculiar formation of stalactites from the Bradford Quicksilver Mine, Lake Co., California. In rainy weather, a brilliant green stalactite forms along the pillars and boards supporting the tunnels of the mine. The foreman of the mine drew my attention to these stalactites, some of which were several feet in length ; but he did not know their chemical composition. Our examination of the mineral gives the following results : in the closed tube, yields a large quantity of water ; and changes color, when cold, showing the red oxide of iron. With soda on charcoal, it forms "hepar" (reacts for sulphur). On charcoal it melts and yields a magnetic mass.

Reagents show the presence of magnesia and iron.

It is *melanterite :* and as most melanterite contains magnesia, the occurrence of magnesia in this instance is easily explained, as serpentine forms the mother rock of the mine. In the Reddington Mine, in Napa Co., California, beautiful crystals of epsomite are of common occurrence.

Melanterite has not been enumerated in the list of California minerals given by Prof. Hanks in his latest report as State Mineralogist. Besides melanterite, I found another mineral not yet reported by Hanks in his State, namely, cyanite. I gave notice of this discovery at a session of the Microscopical Society of San Francisco. Cyanite I found in a very interesting Archæan district in San Diego Co. In this region there exist two isolated basaltic cones, the material of which I may exhibit at some future meeting.

The cinnabar vein in this particular mine is associated with a vein of quartz, which resembles chalcedony in its nature.

The specimen of cinnabar and native mercury taken from the veins in my presence may give an indication of the nature and value of this deposit.

MR. W. E. HIDDEN read a paper describing more in detail the new mineral species, auerlite and sulphohalite, announced by him at the meeting of October 15th.[1]

[1] See Amer. Jour. Science, December, 1888.

DR. H. C. BOLTON read the following communication:

ADDITIONAL NOTES ON THE LUNAR SOCIETY.

Since reading the sketch of the Lunar Society, which flourished in Birmingham one hundred years ago, I have visited that city; and aided by the bibliographical skill and antiquarian knowledge of Samuel Timmins, Esq., I secured some additional items concerning this historic association.

Dr. Priestley, in his pamphlet on the *Generation of Air from Water*, dated 1793, in a note to his Dedication to the Members of the Lunar Society (already quoted), states that they met "every month, on the Monday that was nearest to the full moon," which shows that the members met on a determinate day of the week. He then adds, "We had nothing to do with the *religious* or *political* principles of each other, we were united by a common love of *science*, which we thought sufficient to bring together persons of all distinctions, Christians, Jews, Mahometans, and Heathens, Monarchists and Republicans."

The reputation of this social society of philosophers was not merely local, but reached the continent; for the French chemist, De la Méthérie, writing to James Keir from Paris on the 9th January, 1789, begs to assure the learned Lunar Society of the high esteem and regard in which he held the members.

We have a little additional information concerning Dr. Henry Moyes, whose disputation with the venerable Smeaton we had cited. Dr. Moyes was a Scotch chemist, who had the affliction to be deprived of his sight by small-pox in infancy, and yet acquired an extensive knowledge of natural philosophy and languages, and became a "pleasing philosophical lecturer." His chemical experiments were of course performed by an assistant. In a letter dated, February 6th, 1783, Priestley introduced Moyes to Sir Joseph Banks in very flattering terms, calling him, "A phenomenon in philosophy, being quite blind, yet superior to most who see."

The first meeting of the Lunar Society, after the frightful riots of July, 1791, must have called for all the philosophy which the learned victims could muster. We find several allusions to it: Priestley, in writing to Keir on the 22d July (1791), and again on the 29th, from London, expresses the hope that he may be permitted to return to Birmingham before the next Lunar Society, and begs that the meeting be not made to depend upon his arrival. And Mr. Galton, writing to Priestley on Monday, September 5th (1791), expresses pleasure at the prospect of seeing him in Birmingham, and says: "Our Lunar meeting will be held on Monday at Barr, will that influence you to leave

London any sooner?" (Correspondence preserved in the Warrington Museum.)

Mr. Samuel Garbett, of Knill Court, Herefordshire, in a letter to the Marquis of Lansdowne, dated September 24th, 1791, gives a few interesting particulars of this meeting, held on the 12th at Mr. Galton's, which was probably the first one after the riots. He writes: "My accounts from Birmingham do not show that the acrimony subsides. I am told that Dr. Priestley intended to attend the last Lunar meeting . . . and therefore Mr. Watt, one of the members, went with pistols in his pocket. But Dr. Priestley did not attend the meeting, and I suppose that many of the Presbyterians have beg'd that he may not appear at Birmingham." And in a postscript he adds: "Since writing the other side, I receive a letter from Birmingham in which is the following paragraph: 'Mr. Boulton says he was not at the Lunar meeting; he said Dr. Priestley is not coming, and complains his friends have not *stuck by him.*'"

In the memoir of Dr. William Withering by his son, we find some reference to the Lunar Society. It appears that this accomplished botanist and physician eventually abandoned the favorite doctrine of Phlogiston, so stoutly advocated by Dr. Priestley, and, at one of the social meetings of the "Lunatics," read to them a humorous piece in verse, entitled: "The Life and Death of Phlogiston," which was long remembered for its clever treatment and pointed wit.

On the 30th March, 1798, Dr. Withering wrote to Sir Joseph Banks: "Mr. Boulton was here Tuesday last; he is up to the elbows in coinage, but does not talk of visiting London at present. Mr. Watt has sprained and nearly broken the *tendo Achillis* of his leg, but in other respects is well. My imperfect health prevents me attending our Lunar meetings in the winter season, but I will not forget, as I meet with the parties, to express your kind remembrance of them."

As the Lunar Society was merely social and informal, no records were kept of its gatherings, and we depend on casual references to it in the correspondence of its members with each other, for nearly all the available information concerning it. Further studies of correspondence not known to the writer may reveal additional items of interest.

ADDITIONAL AUTHORITIES.

J. A. Langford's "Century of Birmingham Life." Birmingham, 1868; 8vo, 2 vols.

Robert K. Dent's "Old and New Birmingham." Birmingham, 1879–'80; 3 vols., 4to.

[I. Keir Molliet.] "Sketch of the Life of James Keir." London, n.d. [1868].

[W. Withering.] "The Miscellaneous Tracts of Wm. Withering with a Memoir of his Life, Character, and Writings." London, 1822; 2 vols.

[Priestley.] A volume of sixty-eight letters from Dr. Priestley to Mr. Wilkinson, preserved in the Warrington Library.

DR. J. S. NEWBERRY read the paper of the evening, entitled

THE NEW OIL-FIELD OF COLORADO, AND ITS BEARING ON THE QUESTION OF THE GENESIS OF PETROLEUM.

(Illustrated with specimens and drawings.)

(*Abstract.*)

The speaker had visited during the past summer the oil-bearing region of Colorado, and studied it in both its practical and its scientific aspects. It is evidently an important and promising oil-field, and has interesting geological relations as well.

Petroleum was found as much as twenty years ago in the neighborhood of Cañon City, but no paying wells were worked until within three or four years past. When the speaker was in Colorado in August, the number of wells was about twenty-five; it has now increased to forty, all at or near Florence in the Arkansas Valley, not far from Cañon City. These wells do not spout, but yield a steady supply of from twenty to a hundred barrels daily, the average being about fifty or sixty, and the total about a thousand barrels per day. The land in the entire vicinity, over 50,000 acres, is owned by a single company, and gives indications favorable to a large yield; but actual borings have thus far been made in but a limited part of the area, only a few hundred acres; and surface indications, however promising, are not always proof of permanent and available supply. This was found to be the case in California, where the surface prospect was frequently excellent, but the stratigraphical conditions beneath were unfavorable, and the yield consequently small. Still, the Colorado oil-field bids fair to be an important one, and is favorably situated for delivery upon the market.

From a scientific point of view, it is of much interest to find petroleum here obtained from a new geological horizon, the middle Cretaceous. The oils of Italy and of California are Tertiary; those of Pennsylvania are Devonian; those of Findlay, Ohio, and Collingwood, Canada, are Lower Silurian, etc. Here the rocks that yield the petroleum are the Colorado Shales, which

form the middle member of the Cretaceous system, between the Dakota series below and the Laramie above. In the Upper Missouri region, this middle portion was subdivided into several members, in the well-known classification of Meek and Hayden; but these divisions are comparatively local, and in Colorado all have been united as one great middle series. Their relation is best seen in the N. W. angle of the State, near Glenwood Springs. Here the strata have been steeply tilted, and present the following succession in a length of some four or five miles across the valley of Grand River:

1.	Granite.		
2.	Potsdam sandstone.	300 feet	thick.
3.	Palæozoic limestones.	800 "	"
4.	Triassic.	2500 "	"
5.	Jurassic.	500 "	"
6.	Cretaceous, Dakota series.	300 "	"
7.	" Colorado shales.	2000 "	"
8.	" Laramie series.	3000 "	"

The oil has a pleasant ethereal odor, quite different from that of the Pennsylvania oils, and more like those of Italy. When crude, it has a density of 31° B., and is refined and deodorized with great ease, yielding 40 per cent of very clear and beautiful oil. A large amount of paraffin is left in the residuum, which makes an unequalled lubricant, and would be valuable for that purpose in Eastern markets. The company, however, employ it as fuel in their works, for which purpose it is admirable, but in reality costly.

As regards the geological question of the origin of petroleum, there can be no uncertainty. It is always found in association with bituminous shales or limestones, and is plainly a product of partial distillation from organic matter, chiefly vegetable. If the process goes on further, we have, as the result, the various forms of natural tar, asphalt, ozokerite, bitumen, albertite, grahamite, etc., by a gradual loss of volatile matter and increase in the percentage of carbon. Precisely in the same way, in the coal-series, we pass, by well-known steps, from vegetable fibre through peat, lignite, etc., to the soft or bituminous coals, and from these likewise to the anthracite coals, and finally to graphite. Bituminous coals left exposed to the weather frequently lose their volatile matter, and become worthless for gas-making, much as these bituminous shales are constantly discharging it, and giving rise to gas-wells and oil-wells as the result. The further transition from oil to asphalt may be seen now in some places, *e. g.*, in the great pitch-lake on the island of Trinidad. At many points, it is evident that hard asphalts and asphaltic

coals have been formed by the solidifying and compacting of ancient petroleum in fissures and seams, as at Canajoharie, N. Y. (in the Utica shale), and in the grahamite seams in West Virginia; while in the Laramie rocks of N. W. Colorado there are "veins" of albertite several feet thick, evidently resulting from the hardening of petroleum derived from the Colorado shales beneath.

All the indications point clearly to organic matter deposited in sedimentary rocks, as the source of all these carbonaceous materials. Exposed to the atmosphere, such matter rapidly decomposes into gaseous products, mainly carbonic dioxide and water-vapor. But shut off from the free access of the air, either under water or buried in sediment, a series of complicated changes sets in, by chemical reaction among the constituent elements of the organic matter itself. These form among themselves a variety of products, solid, liquid, and gaseous. The latter gradually escape, rising into overlying beds, where they often accumulate in cavities, if such there be, and form reservoirs of natural gas and light oils. The heavier products remain below, blackening the rock with their residual carbon and hydrocarbons, which latter are ready to go on with the process of further loss of volatile matter, as long as any remains.

Processes of a similar kind are constantly in progress, and may sometimes be witnessed on a small scale. In pools of water, where decaying vegetable matter has accumulated at the bottom, both oily and volatile products are formed. A thin film of oil may be observed on the surface of the water, and marsh-gas (so named from this familiar fact) is given off in bubbles upon stirring the mud with a stick.

All these facts point unmistakably to organic matter as the source of natural gas-wells and oil-springs, as well as of the coals and asphalts in all their forms. Most of the material is doubtless vegetable, though some small amount may be derived from animal remains, as, *e. g.*, adipocere is not unfrequently cast up on the sea-shore. But these cases are exceptional.

Such considerations aid us to a solution of the question regarding the permanence of the oil and gas supply. Three points will be clear, viz.: (1.) Such wells and springs will be confined to strata underlain by large deposits of organic matter, as coal or bituminous limestones and shales. (2.) Oil and gas will escape from such strata as long as any organic matter is left. (3.) The daily amount produced will be small, and no large accumulations can form, save in cases where two conditions are present, viz.: fissured or porous rocks, which may serve as reservoirs for the distilled hydrocarbons; and impervious beds above, which will prevent their escape. In such cases, the slow yield of centuries

may accumulate in large amounts. When openings, natural or artificial, reach such strata, we have spouting and flowing wells, and the flow may continue for a very long time; but if the reservoirs become exhausted, or the borings become so many as to divide the product among a great number of openings, the discharge is reduced and may even cease to be profitable.

This result has been seen in the oil-wells at Mecca, Ohio. The borings are made into the Berea grit, a sandstone that was found to be charged with petroleum. It overlies the Cleveland shale, which is black with carbonaceous matter, and is the evident source of the oil in the grit above. So great was the oil-yield at first, and the consequent speculation, that hundreds of wells were bored in close proximity; and the effect was to drain off the supply so rapidly that in three months all the wells were apparently exhausted, and were abandoned. But the natural process of renewal goes on from below, and now a small but remunerative business is carried on by pumping each well for a few days in the year. The small but regular supply thus obtained proves the steady continuance of production; and as neither gas nor oil is found or developed below the Cleveland shale, the latter is plainly the only possible source.

In the Old World, we have striking examples of this continuous natural production lasting for ages. This is the case in China and Hindostan, and markedly on the shores of the Caspian Sea, where the great petroleum region of Baku has been discharging oil and gas from the ground, time out of mind. So, too, at Babylon, the asphalt used for mortar, in ancient times, is still furnished by the bitumen springs of the neighborhood. In all such cases, where the natural supply alone is used, it is practically permanent; but the rapid modern methods of pumping, and the great multiplication of wells, tend to exhaust local reservoirs, and outrun the rate of spontaneous renewal.

The subject was discussed by MR. HIDDEN and Vice-President HUBBARD.

December 3, 1888.

REGULAR BUSINESS MEETING.

Vice-President HUBBARD in the chair.

Forty-nine persons present.

The report of the Council was presented, and its recommendations adopted as follows:

1. The payment of certain bills.

2. The appropriation of $100 for binding periodicals received prior to the removal of the Library to its present location.

3. The election of the following persons as resident members:—MR. BASHFORD DEANE, of the College of the City of New York; PROF. ROBERT W. HALL, of the New York University; and as corresponding member, PROF. HENRY A. WARD, of Rochester, N. Y.

The Corresponding Secretary, DR. A. A. JULIEN, read letters of acknowledgment of election as honorary members, from Professor ROSWELL P. FLOWER, of the British Museum, and Baron FERDINAND VON MUELLER, of Melbourne, Australia. Also,

The Librarian, DR. BRITTON, announced the receipt of a series of publications, comprising five volumes of miscellaneous botanical papers, issued at different times by BARON VON MUELLER, as a gift to the Academy's Library, and also, through his agency, fourteen "decades" of McCoy's Prodromus of the Zoölogy of Victoria.

DR. JAMES J. FRIEDRICH exhibited a series of specimens of silicified woods from California, and remarked upon them as follows:

I wish to present a few specimens of petrified wood from California. Petrified wood is found almost all over the State; but there are a few counties where it is met with in such abundance, that it is a common occurrence in the floats and in the beds and washouts of rivers and creeks; such is the case in Napa and Sonoma Cos. In Santa Rosa, Sonoma Co., are some very active collectors, and among their collections specimens of petrified wood form an important part. Still, the specimens from Sonoma Co.—between Santa Rosa and Petaluma—show nothing remarkable; but the abundance of silicified objects, such as pine-nuts,

roots and branches of trees, rhizomas, reeds and grass, proves that the country must have been submerged and subjected to the influence of alkaline waters holding silicic acid in solution.

The specimens from Napa Co., around St. Helena, where the "glass mountains" form an important feature, are of much more interest. 1. A specimen of wood-opal from Howell Montain, shows the organic structure most beautifully; in the closed tube small fragments yield a large quantity of water. 2. This bottle contains fibres of silicified wood, found about ten feet below the surface in an excavation in an eruptive conglomerate at Schramsberg, about four miles from St. Helena. The same conglomerate I found again at the road section from the toll-house to the Bradford Mine in Lake Co. The excavation was made for the purpose of making a cave in the mountain for the storage of wine. These fibres examined under the microscope show the structure of cellulose fibres very plainly. About half a mile from the farm buildings, the remains of the trunks of three petrified trees are found in a ravine; some of the specimens show also a desiccating process in the formation of fibres. The conglomerate is overlain by a tufaceous rock, which is also found to overlie the obsidian at the glass mountains north of St. Helena. It is therefore evident that the conglomerate, in which the specimen in question was found, must be of about the same age as the black obsidian, viz.: Tertiary.

I have yet to present two other specimens, 3. a piece of petrified pitch-pine from Placer Co., and, 4. for curiosity's sake, a piece of a petrified trunk, 180 feet long and 7 to 8 feet in diameter, found by Prospector Reese in Dead Valley, Mono Co.; this isolated trunk was taken up as a quartz ledge, supposed to be gold-bearing.

Remarks were made by DR. N. L. BRITTON and PROF. D. S. MARTIN, the former in regard to the micro-botanical structure, and the latter concerning the geological occurrence of these silicified woods. They are probably of the same age as those of Nevada Co., which are found similarly in gravel, etc., overlain by volcanic material, lavas or tufas, of late Tertiary age, as is the case along much of the west side of the Sierra Nevada. The underlying gravels and conglomerates are the ancient auriferous

stream-beds that are so now much worked by the hydraulic process.

DR. BRITTON reported the discovery of an outcrop of Cretaceous clays on Staten Island, near Grasmere Station, at a point beyond previous identification, but lying within the area indicated as Cretaceous in his map of the island, and so confirming the correctness of the views therein embodied.

DR. HUBBARD spoke of a published statement to the effect that woodchucks and foxes climb trees.

MR. E. B. SOUTHWICK stated that he had seen foxes on rail fences, and had caught woodchucks at a height of eighteen feet on trees.

The paper of the evening was then read by DR. H. NICHOLAS JARCHOW, entitled:

FORESTRY IN THE STATE OF NEW YORK, WITH SPECIAL REFERENCE TO THE NEED OF TRAINED FORESTERS AND THE SUCCESS ATTAINED IN THAT DEPARTMENT ABROAD.

Mr. President, and Ladies and Gentlemen:—The forests of our State are in a bad condition; that is conceded by all; but they are not by far in such a miserable condition as were 150 years ago the forests of Germany, which are in so fine a state of cultivation to-day. The devastations caused to the forests by the Thirty Years' War and by the internal political troubles, as well as the necessity to the owners of the large forests (governments and corporations) of deriving an adequate income from their property, made it imperative that something should be done in order to restore and properly to sustain the woods. To bring about this result, many scientific men devoted themselves to the exclusive study of forest treatment, and perceiving the necessity of intrusting the management of forests to a specially educated and trained body of officials, possessing the requisite knowledge and information, they gathered around them—as in ancient times did the teachers in philosophy—young, enthusiastic men, and imparted to them the knowledge and experience which they themselves had acquired by many years of observation and study. The most successful teacher in this line was the overforestmaster *von Langen* at Brunswick. He was the chief officer in charge of the forests in the dukedom of Brunswick, a little territory of about one and a half millions of acres, one-third of which consisted chiefly of mountains formerly covered with dense forests, but then nearly denuded. As the income of

the Duke was largely confined to this montainous region, called the Harz, von Langen devised a plan by which care was taken always to have a sustained growth of wood and a natural restoration of the forest. This man, who is justly considered the principal founder of the present system of scientific forest-management, had always in the execution of his work young men for his assistants, to whom he imparted theoretical and practical instruction, and from a body of such men he established in the year 1772 the first school of forestry. At this school arrangements were made for forestal experimental research; and everything was done to reduce the practical results to a *scientific basis.* For this reason, the advanced forest-economy of to-day is rightly called *Scientific Forestry;* and, if we would know what this means, it is, first, the maintenance of a sustained forestal production from a certain area; second, the natural regeneration of these forests; and third, a progressive improvement of the forest in place of former deterioration.

Now, gentlemen, you may say, this is all very well; but how about the expenses? Does it pay to manage forests in the expensive way just mentioned, even on the poor soil of the mountains? This question can undoubtedly be answered in the affirmative, supposing the management to be placed in the hands of experts and not given to mere politicians. I recently had before me an official publication issued every year by the German government, in regard to the average production of wood in the State forests and the revenues derived therefrom. These publications are very instructive, and serve much to encourage the introduction of scientific forest-culture on the estates of corporations and private persons in that country. From a publication of this kind for the year 1856, I perceive that the management of the 250,000 acres of Government forests in the little dukedom of Brunswick above mentioned, involved an expense of $278,000, or about one dollar per acre, and that the income for that year was $635,000, or about two dollars and a quarter per acre. The net proceeds of an acre of woodland were therefore about one dollar and a quarter. Very interesting is the same publication, issued thirty years later, in 1886, from which we see that, after deducting the expenses, amounting to about two dollars per acre, the income of the forests, not only in Brunswick but in all other parts of Germany, had increased to over two dollars per acre by this management. Considering that in the densely populated Old World only such soil is allowed to be kept in wood as is unfit for agricultural purposes, it will be seen that, leaving out of the question the beneficial climatic influences and other economic advantages,

which are due to the forests, two dollars per acre is a pretty good profit.

How does this compare with our 850,000 acres of State woodland? To be brief, the State has, up to this date, not only received no income from its woodlands, but has had to pay a handsome sum every year for the honor of being possessor of such extensive forests. Now, gentlemen, the blame for this state of affairs does not fall upon the Legislature of our State, for Section 18 of the Act passed on May 15, 1885, contains the following provision:

"The Forest Commission shall take such measures as the Department of Public Instruction, the Regents of the University and the Forest Commission may approve for awakening an interest in behalf of forestry in the public schools, academies and colleges of the State, and of imparting some degree of elementary instruction upon this subject therein."

If this provision were carried out, the Empire State would inaugurate a new era in political economy, and would lay the foundation upon which to build the science of systematic forest-culture, as it would give rise to forest-schools. And experience teaches us that in all countries where profitable and systematic management of the forests has been successfully introduced, the first step to it was the establishment of schools of forestry. For men educated in such schools become not only fit for their vocation, but consider their position as a trust, and perform their duty to the government, not only impelled by their fealty to the public authorities, but by a professional sense which makes dear to them the forests given to their care and protection. From unskilled hired men you cannot expect such a devotion to the interests of the position as is developed in a trained forester.

Whether our public schools will be the proper places for awakening interest in behalf of forestry, we will leave out of this discussion; but our agricultural colleges should consider it their duty to impart not only elementary, but full scientific information upon this subject. At present it might be sufficient if only some one of our liberally endowed institutions should undertake this task.

In Europe, colleges of agriculture and forestry are now generally combined with the great universities, in order to give to the students of the special branches an opportunity for general scientific development. It requires two years of study to complete the forestry course alone. During the winter months, instruction is given in the several branches of forest-science; while the summer months, after deducting some weeks for vacations, are employed in making excursions to places

where forest operations are going on, or where the students have an opportunity to practise what they have learned during the winter. The full winter courses give instruction in :

(1) Cultivation of forest trees and the uses to which their woods may be applied, with the mode of propagating them in different soils.

(2) Forest exploitation and the management of forests according to the various systems now in use.

(3) Forest taxation and mensuration.

(4) Surveying, draining and embanking.

(5) The methods of resisting the encroachments of shifting sands by binding and planting them with forest-trees.

(6) Care and chase of game.

(7) Laws and regulations governing the forests.

The examination which the candidates must undergo is very strict ; and the result of this system has proved eminently beneficial to the management of forests.

But at present it would be of far greater advantage to our State to establish a simple "School of Forestry," in which young men could receive the proper training to qualify them for appointment to subordinate positions in the forest service. France has done much to educate good foresters, tree-wardens, etc., by purchasing the well-known forest-farm "*Barres*," situated about 1,000 feet above sea-level, near the great Orleans forests. This farm had already been used by its owner, M. Vilmorin, for forty years as a *private experimental station for forest-trees*, with the following objects :

(1) Investigations in regard to the most profitable use of certain soils for raising the most valuable kinds of wood. With this department there were connected experiments for acclimatizing valuable foreign forest-trees.

(2) Raising at the least possible expense the greatest amount of good seedlings, combined with observations in regard to the yearly increase of wood in the various forest-trees.

(3) Producing and closely examining the seeds used in the State forests.

The French government, notwithstanding the great financial trouble at that time, bought this farm in 1873, for the purpose of establishing there a "government school of forestry." This was done without interfering in any way with the objects to which the farm had been for a long time so beneficially subservient. To this establishment there was simply added :

(4) The "school of forestry," in which young men obtain such information as to enable them, after the completion of the full course, to act as foresters, forest-inspectors, tree-wardens, etc.

The course lasts through two years, and is more calculated for

practical instruction than for high scientific education. To impart the latter, and to raise the higher officers in the Department of Forestry, the world-known Academy at Nancy is designed, and is considered fully sufficient for all France. At "Barres," instruction is given only in some sciences, in order to enable men brought up in common schools to concentrate their mental power upon practical subjects. Only during the four winter months, therefore, is *elementary information* given to them in mathematics, surveying and levelling, and forest botany, zoology and entomology; while thorough instruction is furnished in the management of forests, with special reference to their artificial and spontaneous re-stocking; in the modes of finding out the amount of net income from the forests; and finally, in the laws and regulations by which the administration of forests is governed.

This institution is now a public one. A certain number of young men, between the ages of nineteen and twenty-four, are every year received, and after two years of study, and then passing the examination, they get appointments to the lower positions among the forest-officers, advancing to higher positions after some years' service and having passed further examinations. The pupils, like our West Point cadets, are educated entirely at public expense, receiving even a small salary as pocket-money. But they have, during the seven working months of the year (one being devoted to rest and vacation), to perform every manual labor required on the farm in cultivating the soil, raising seeds and seedlings for nearly free distribution among the French farmers, and all other work connected with the institution. Besides this, they have to do in the adjoining State forests every kind of labor which is needed to retain the woods in a first-rate condition; they therefore have personally to do the seeding, planting, thinning, and cutting of trees, making roads, openings, ditches, etc., in order to learn practically every work that may occur in the course of systematic treatment of forests, as these later will come under their care and guidance.

To establish in or near the Adirondacks a school like this would be a move in the right direction for bringing into effect the well-meant provision of the quoted Section 18 of the Forestry Act. It is true that the report of the Forestry Division of the Agricultural Department at Washington, published in 1884, very strongly recommends the establishment of schools of for estry by the Federal Government. But to wait till this sensible advice should be acted upon, would show too much faith in the activity of our Congress regarding matters other than simply political. It is the duty of each State in the Union to take care of its forestal interests, and to educate its own officers, especially

as diversity of climate, situation and other economic reasons will make the proper training of the foresters in the various States in certain respects a diversified one.

As for the cost of establishing and maintaining such an institution, it would not be large, especially if adjoining States of similar climate and topography would unite and contribute proportionately to its support. Indeed, the labor performed by the students upon the grounds of the institution would make it nearly self-supporting; and the demand for trained foresters in the United States would bring more pupils than could be accommodated. But the benefit which our commonwealth would derive from the introduction of a systematic treatment of the State forests would be so great as to make it nearly impossible now to give even an approximate estimate of its value. Besides setting a good example in the management of forests, to be followed by private citizens, and deriving a considerable income from the State forests, the army of men who are now used by unscrupulous lumbermen and their agents in illegally cutting timber on the State grounds, and who are becoming every year more depraved on account of the unpunished continuance of their public plundering, could then easily be made to return to an honest and well paid activity, as a great many hands would be required for bringing the State forests into such a shape as to secure (1) a sustained forestal growth; (2) a natural regeneration of the trees; and (3) a continually improving condition of the forests.

DISCUSSION.

DR. HUBBARD opened the discussion by remarking that some time ago he was reading the laws of New York of 1810, in regard to the preservation of fish, and that he doubted, notwithstanding those laws, whether a salmon could now be found in the streams of western New York. There is no reason why these rivers could not be re-stocked. In 1810, it was also the law that mills should never build a dam such that a salmon could not ascend the stream; but that provision is probably a dead letter. We have good laws, but what is needed is a more thorough and careful enforcement of them. It is the same with regard to our forests in a great degree.

MR. J. C. HENDERSON remarked that he had lived a good deal in the West, in sections of the country where there are few trees, and had noticed a certain enthusiasm among the people for arboriculture, which there is not in the East. Where people

do not have trees, they learn to value them. In some of the towns of the far West, there is a time given up entirely in the public schools to planting trees; the children go out, and the teachers gather with them, and plant trees, and all find it a very pleasant task. Whatever, also, could avert forest fires, which are such a calamity to this country, would prove a blessing to posterity; and he felt that this Academy, in seeking to advance the interests of forestry, certainly deserved encouragement. People who are brought up in the city, and have lived there all their lives, hardly know what trees are; and he believed that the most work could be done in the country schools. We have agricultural colleges where it is a business to raise trees and study their culture, but a great deal more might be done in this direction. He observed further that there are some persons who take up land under our present statutes and plant trees; but just as soon as they are at all grown, cut them down and, instead of maintaining a forest growth, use the land for pasturage merely, making the trees a pretext for obtaining the land at low rates. No more important subject than this could possibly come before the Society.

Prof. D. S. Martin said that in the matter which Dr. Jarchow nas presented to us, of Forestry education, there is one institution in this State which might very properly take it up, and establish a department of this kind, with great advantage. We have no colleges very near to the Adirondacks, the nearest being Union College, at Schenectady. But Cornell University is near enough; and when this institution was established it was the very idea of its founder to provide education for young men in any required pursuit, and provision was made for various departments to be added as needs might arise for which there was no instruction provided elsewhere. This seems to be altogether the most appropriate and available place for locating such a School of Forestry. There are two or three directions in which the State Forestry Association should work:—First, it should seek to present the subject in different places throughout the State, wherever popular enthusiasm and interest could be aroused;—second, there should be a bill drawn up and laid before the Legislature, to restrict the reckless lumber trade, which thinks of

nothing more than getting the largest present profit out of the forest lands of the Adirondacks, in utter ignorance or disregard of consequences;—and third, there should be an agitation of the question of establishing a Forestry school at Cornell University.

Very much is said in this country about "the development of our natural resources." There are some of our natural resources than can be just as well developed ten years hence or a generation hence; but in the matter of tree-culture we are losing constantly; whatever precious metals are hidden in the rocks can wait; there will be just as much of them hereafter as there is now; but it is not so with our forests—they are being denuded and removed year after year. We are beginning to see the consequences—the effect which the cutting-away of our forests has upon the rain-fall and the climate, in the alternation of summer droughts and spring floods, with all the destruction of life and property which these entail. This is the harvest that we are beginning to reap from the denudation of our hill-tops. It is imperative that all who are at all alive to these subjects should take up the cause strongly and earnestly against the army of men, thoughtless and unprincipled, who are employed in cutting the wood from our mountain slopes. This is the greatest and most immediate need of this country. We shall probably in time profit by the lessons thus dearly learned; but meanwhile, on the slopes of the Adirondacks and the Alleghanies, and in both peninsulas of Michigan, there is this persistent wood-cutting in progress, which means the devastation of the whole region. He hoped the matter would not expend itself in mere discussion; it is well for us to talk, but the Academy should take up the subject actively, and present a petition to the State authorities, in conjunction with the State Forestry Association, in behalf of immediate legislation.

Rev. J. S. Spencer remarked that, in travelling through Spain, one would find the roads lined with fruit-trees in every direction, which fruit all travellers (men, women, and children) were at liberty to eat. This growth of fruit-trees throughout Spain is due to the fact, that, in eating the fruit, it is a habit to take the seed or stone and plant it by the roadside for the future benefit of travellers. One of the greatest evils of the bom-

bardment of Paris was the destruction of trees in the Bois de Boulogne, but there the government is actively interested. Nothing impresses one so much, in riding through Paris, as the great avenues all lined with trees. The value of every tree is known to the authorities; every tree is numbered and registered; if one is sick it is cared for, and if it dies, it is replaced; so that the old city presents a scene of beauty that is always the same. The scarcity of trees in New York is a noticeable fact to strangers. There is no doubt that health would be very largely promoted by the cultivation of trees, and this society could engage in nothing of more importance than the subject presented to-night. But before there can be any intelligent care or protection for trees or forests, there must be first the growth of sentiment among the people, and enthusiasm must be aroused. We ought to have a sense of reverence for a tree, when we think of the time that is spent in its growth, and of the inability of man to restore it. If we felt all this, we should be very loath to injure a tree. I have read of a nobleman in England who was showing a merchant through his park, and when they came to a magnificent oak, the merchant, thinking only of money, said: "Why don't you cut that tree down?—you could build a ship with it." "Cut it down!" replied the nobleman,—"I would rather get down on my knees and worship it."

Mr. W. H. J. Sieberg said that he thought that sentiment had little to do with the case. The farmer thinks more of his dollars and cents than of the nobility and grandeur of his trees; and if this Association could succeed in showing a farmer that there is profit in trees,—that there is a way of gaining money from keeping his forests in a proper condition,—there would not be such waste and indifference, and he would care for his forest more intelligently. A farmer burns his trees down to get them out of the way and open the land for agriculture; if we can in any way demonstrate to him that by proper cultivation of woods he can make as much as by burning or cutting them down, he will spare the forest. We do not need so much to develop sentiment as to show these people where their practical interest lies; when that is done, we can succeed.

Dr. Hubbard made some further observations upon the

culture of trees and the effect of forest-removal in certain localities. Referring to northern New England, he cited the fact that the Connecticut River has diminished at least two feet in its average depth, because so much woodland has been cut away, allowing the water to run off too quickly; the resulting wash from the hills also tends to fill up the river. The fruit, moreover, is not so good as it was years ago, partly because there are no forest-trees for the insects to live upon, and also because fruit-trees are injured by want of protection from the inclement blasts. It takes so long to raise a forest that country people have not patience;—they will not settle down to it; a man of forty is not willing to set out a forest, as in ten or fifteen years he may want to move elsewhere. People who settled in the West when it was first opened are looking now for another move, and merely stay long enough in one place to plant a few trees in a garden patch.

There is a method used in some places where charcoal is made; the forests are allowed to grow again in rotation over specified areas; they are cut from a hill-side in a belt of a certain width, and that is left to grow up, while other places are similarly cut from year to year. Thus all can be gradually renewed, if protected from the incursions of lumbermen and from fires. On one occasion, years ago, when walking under the justly celebrated elms of New Haven, he picked up a handful of elm seed, and planted it at his home in Hanover, N. H. The young trees grew rapidly, and in two or three years had spread seventy feet. There is no difficulty in raising trees, any more than grass; but in the case of trees, especially fruit-trees, there is an art in setting them out; yet in general it is just as easy to transplant a tree as any other plant.

Dr. Britton then observed that we had with us Mr. Dudley and Mr. Southwick, who had been actively interested in the State Forestry Association, and that he should like to know a little about the Forestry Commission, where it had established itself, its present working, what it is accomplishing, etc.

Mr. E. B. Southwick said he had sent for the records, and had examined several libraries, but without success; therefore he was not able to state very much at this time, but presumed he could report before long. In regard to the preservation of

the local forests, one difficulty arises from the fact that a great deal of the woodland is claimed by individuals; and the fight will be a pretty severe one, particularly in certain of the northern counties. It will be years before the Association can do much in that region; and as far as the Academy is concerned, it should not make any precipitate resolutions upon this subject until it can be assured that the present law is not being carried out as was intended.

It was then proposed and voted that the thanks of the Academy be tendered to Dr. Jarchow and Prof. Southwick, as all had been greatly interested in the topic.

December 10, 1888.

No meeting was held on this evening.

December 17, 1888.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-three persons present.

The following papers were read by title :—

DESCRIPTION OF A NEW SPECIES OF SPERMOPHILE FROM CALIFORNIA (SPERMOPHILUS BELDINGI), BY C. HART MERRIAM.

A PRELIMINARY MONOGRAPH OF THE NORTH AMERICAN SPECIES OF TROGOPHLŒUS, BY THOMAS L. CASEY.

These papers appear in the Annals, Vol. IV., Nos. 10, 11.

DR. JOHN S. NEWBERRY read the paper of the evening, entitled :

THE PAVEMENTS OF THE GREAT CITIES OF EUROPE, WITH A REVIEW OF THE BEST MATERIALS AND METHODS AVAILABLE FOR THE PAVING OF THE CITY OF NEW YORK.

(Abstract.)

In no other great city of Europe or America are the pavements so bad as in New York. This is due to two causes, the defects

of the material used and a want of care and skill in putting it down. The material is almost without exception the trap-rock (diabase) of the Palisades. This is exceedingly tough and durable and makes a very lasting pavement, but it is wrought with great difficulty, and the blocks have therefore not been made of uniform size, nor smoothly dressed, so as to fit closely to each other. As a consequence there are wide, irregular spaces between them, which become filled up with street rubbish that can never be removed by ordinary processes of street-cleaning. The trap also, by wear, becomes exceedingly smooth and slippery, and as the blocks are on an average five inches in diameter, their surfaces give an insecure foothold to horses, and many falls are the result. From its great strength and durability, the trap makes a good pavement for those portions of the city that are much crowded with heavy, slow-moving trucks, but it is quite unfit for paving streets lined with residences and traversed by swiftly moving vehicles.

A better pavement than that of trap is formed by the granite which has recently been laid in Fifth Avenue; but this is faulty in that the blocks are too large, their surfaces becoming smooth and slippery, and the joints, by the crimping of the edges, being large and filled with filth. A good pavement may be made from granite blocks, but they should be carefully dressed and fitted together, and be much smaller than those in use here.

In the Old World, the selection and preparation of the paving blocks are scarcely more than half the work of properly paving a street; for there the roadway is most carefully prepared, and the blocks, whether stone or wood, are laid in concrete and are therefore of uniform height, producing a relatively smooth surface.

Repeated inspections of the pavements in use in the large cities of Europe have shown me a gradual improvement in materials and methods which has finally brought the art of street paving to its highest possible development. In my student days, when I lived in Paris, all the streets were paved with cubes of Fontainebleau sandstone; these were carefully laid and formed a serviceable but noisy pavement. Partly to correct this latter characteristic, and partly to get rid of materials specially adapted to the formation of barricades, the block pavement was removed from the principal streets and replaced with a kind of asphalt Macadam. Now, Paris is chiefly paved with wood and with Seyssel asphalt, both carefully laid and equally liked for their cleanliness and stillness and the easy draft of vehicles over them.

The pavements of Berlin are partly stone and partly asphalt; both, like the pavements of Paris, being well laid and illustrating

the excellences of the two systems. It is, however, unfortunate that the two kinds of pavement are mixed as they are, since the stone blocks keep the shoes of horses smooth, and then, passing on to asphalt, they are liable to slip.

All city streets in Belgium are paved with stone cubes. The material used is generally the "Psammite of Condroz," which is tough and durable and yet always has a grain that prevents the surface from becoming very smooth. As compared with asphalt, the Belgium pavement is always rough and noisy.

In London, the question of pavements has been solved by long-continued experiments with all kinds of material ever used for this purpose, and it is not too much to say that the best examples of all the varieties of pavement in use are found there. Four kinds of pavements have been adopted, viz.: (1) *Granite blocks*, which are never more than three inches wide and six or seven inches long. They are all carefully dressed, nicely fitted together and bedded in concrete, so that they furnish a relatively smooth and durable surface. (2) *Wood pavement*, which is our Nicholson improved. The blocks are pieces sawed from fir planks, three inches thick by eight inches wide. These are in some cases creasotized, sometimes not; they are closely fitted together, being separated only by strips of felt, are bedded in concrete and carefully maintained, a defective block being removed at once. (3) *The Macadam*, used on the broad roadway along the Thames embankment; it is smooth enough, affords good foothold to horses, and is relatively cheap, but it is nothing like so clean as the stone or wooden pavements. (4) *Asphalt pavement*. Of this two varieties are in use, in one of which the asphalt is mingled with clay or sand, in the other with gravel. Most of the asphalt pavement seems to be made from the Seyssel or the Sicily asphaltic rock, much as it occurs in nature. This pavement is acknowledged to be the best in London. When the roadbed is carefully prepared and the asphalt is skilfully applied, streets thus covered are smooth, clean, silent, pleasant to ride over, easy for horses, and salubrious. The asphalt pavement is also durable; it has been stated that horses are more liable to slip upon it and that where it is used accidents are more frequent, but careful and long-continued observations prove the contrary. It will thus be seen that this is nearly a perfect pavement, and it is not surprising that it is rapidly growing in favor.

The experience of the Old World has clearly shown the people of New York how they can improve the pavements of the city by substituting the best for the worst at no enormbus cost, and be great gainers in many different ways. They have a choice of several kinds of material as good as any attainable anywhere.

The trap affords paving-stone of great durability and is available for those parts of the city bordering on the docks, where heavy slow-moving vehicles are used, but it would add very much to the value of this pavement if the blocks were made narrower and the roadbed was more carefully prepared. Granite of excellent quality can be brought to the city from the banks of the Hudson about West Point, at a cost as low as such material can be obtained in any city in the world. Bluestone can be furnished at a still lower price. It makes the best flagging and curbing of any material known, and would supply paving-stones fully equal to those made of the psammite of Condroz or the Fontainebleau sandstone.

For asphalt pavements, all the requisites can be obtained here of excellent quality and at a relatively low price.

Many years ago a series of experiments made by Mr. A. C. Campbell, at the School of Mines, showed that the Trinidad asphalt, which can be brought here cheaply, could be mingled with sand and other substances, so as to produce a mastic equal in strength and durability to that formed from the Swiss or the Sicilian rock; and lately more thorough and extended investigations made by Mr. H. C. Bowen, have demonstrated that with proper treatment better results can be attained from artificial mastics, made from these materials, than from any natural asphalt rock known. But the question of the possibility of making an excellent pavement from Trinidad asphalt has gone far beyond laboratory experiments; for this is already done on a large scale and with great success by at least one asphalt paving company, the Barber, in several American cities.

The paper was illustrated with specimens of asphalt, etc., from various localities.

Remarks were made upon the subject treated of in the paper, by Messrs. CHITTENDEN, COLLINGWOOD, HOLBROOK, MARTIN, and TROWBRIDGE.

MR. WILLIAM COOPER exhibited a series of polished slabs of the beautiful aragonite breccia (called "mosaic agate") from the volcano of Zempoaltepetl, in Southern Mexico, near the Central American line. He described the locality, which he had recently visited, though heretofore very remote and inaccessible, and gave some account of the mode of occurrence of this material, which it is now proposed to introduce for ornamental purposes.

The specimens were greatly admired; and remarks thereon were made by the President.

January 7, 1889.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the Chair.

Forty-two persons present.

The report of the Council was read, recommending the payment of certain minor bills.

DR. JAMES J. FRIEDRICH exhibited and described some remarkable minerals from the copper district of Arizona, as follows:

I wish to present a few specimens from Bisbee, Arizona, viz. (1) a beautiful green calcite and (2) an aragonitic stalactite: The calcite is imbedded in a mass of malachite; in the centre of the stalactitic columns, fine apertures are observed, around which silky fibres of malachite are arranged concentrically. Through these apertures malachite penetrated the columns, coloring them in some instances only in the centre, while in other columns the whole mass of the calcite is penetrated and tinted. The most beautiful coralloidal specimens of aragonite come from the Silver Spray Mine, which is at present not accessible; private collections in Tombstone contain very fine large specimens, resembling a good-sized coral-stem, with its branches perfectly white and translucent. In this region of the carbonates, it is very natural that pseudomorphs and imitative shapes should be very frequent; and the one mineral which is best adapted for the purpose is azurite. Pure massive azurite, translucent and bearing in its crystallized form a close resemblance to epidote, is rarely found. This specimen (3) in point I obtained at the Silver Bear Mine, at which mine exclusively chalcocite also occurs.

(4.) The next specimen is a perfect pseudomorph of azurite after calcite; I procured it from a dealer in San Francisco, who would not tell me the locality where it was found, but I presume it to be from Black Co., N. M., where fine specimens of azurite are not rare.

(5.) These specimens are oölitic in structure; the materials generally found to build up the different layers of the concretions are tenorite, malachite, and azurite. The same construction is seen in No. 6 in stalactitic shapes and incrustations.

No. 7 is one of the most instructive specimens, exhibiting all the various degrees of metamorphism. This piece of ore shows in its totality the structure of fibrous aragonite; the principal

mass is penetrated by azurite, but at the same time one may observe nodules of tenorite; patches of malachite, in some instances coarsely fibrous, and in one place a bluish-green concretion, which forms a new mineral, the so-called calco-malachite, of which you have here (8) a larger and handsomer specimen. No. 7, above described, is therefore a truly representative specimen of the Bisbee copper region.

These are not by any means the handsomest specimens obtained from Bisbee; fine minerals from this locality are by no means rare; still, I succeeded in getting some choice material from old excavations, such as very beautiful malachitic stalactites, etc., which may compete with any Bisbee specimens ever exhibited.

MR. W. H. J. SIEBERG, in behalf of the committee appointed to prepare a minute in regard to the late MR. CHAMBERLIN, presented the following report:

To the N. Y. Academy of Sciences:

Your committee, appointed to report a memorial and resolutions on the death of our late member MR. B. B. CHAMBERLIN, respectfully report as follows:

Benjamin B. Chamberlin, for many years an honored member of the Academy of Sciences, and one of its Fellows and Curators, died at the home of his brother-in-law, Mr. E. H. Cole, at Nyack on the Hudson, on the 13th of October last, in the 58th year of his age. Born at Keeseville, N. Y., March 13th, 1831, he was sent by his father, Rev. Parmalee Chamberlin, to the Peekskill Military Academy to be educated; thence to Irving Institute, where he was graduated with high honors in the same class with General Adam Badeau. He immediately entered business, studying engraving with Benson J. Lossing, the historian.

After one year's military service in Ohio, during the time of Morgan's raid, he came to New York and began to devote himself energetically to the collection of minerals, principally those of Manhattan Island and vicinity; this he regarded as his life-work, completed but a few days before his death by the publication in pamphlet form of his list of the minerals of New York Island, a paper which he had previously presented at a meeting of the Academy of Sciences.

He was one of the founders and the Treasurer of the New York Mineralogical Club, a member of the Agassiz Association of Nyack, and also of the West End Natural History Association of this city. A lover of nature, he delighted in painting out-door scenes, and was quite skilful as an artist, both in oil and

water-colors; a man of genial and quiet manners, he made hosts of friends.

Your committee, in conclusion, recommend the adoption of the following:—

Whereas, It has pleased an all-wise Providence to remove from our midst our late friend and fellow-member Benjamin B. Chamberlin; therefore,

Resolved, That we tender his surviving relatives our heartfelt sympathy in their bereavement.

Resolved, That in his death we recognize the loss to science, and to ourselves, of an earnest friend and fellow-worker, whose place in the field of local mineralogy it will be hard to fill.

Resolved, That a copy of this memorial and accompanying resolutions, properly signed by the officers of the Academy of Sciences, be forwarded to the relatives of the deceased and published in the Transactions of the Academy.

W. H. J. Sieberg,
Daniel S. Martin,
George F. Kunz,
} Committee.

The resolutions were unanimously adopted, and their transmission and publication ordered.

Mr. Theodore D. Rand, of the Academy of Natural Sciences of Philadelphia, then presented the paper of the evening, entitled

A DISCUSSION ON THE ROCKS OF PENNSYLVANIA AND NEW YORK.

Having given some study to the geology of the region lying west of Philadelphia, I have come before you to state some facts in relation to it, and to compare views with your members, in hope that we may thus get new light on both regions; for there can be no question that the same group of rocks underlies both the cities of New York and Philadelphia, as well as the city of Baltimore. While there has been much discussion as to the age of these rocks, no theory has been largely accepted.

In one respect Philadelphia is better situated for this study than New York, as we have near us certain rocks, the age of which is known almost without doubt, though on the other hand the Philadelphia rocks are much more decomposed and covered.

Upon the wall I have placed a section of the rocks from the Triassic of Montgomery Co., Pa., south-eastward to the Cretaceous of New Jersey (see Plate), and also an excellent map by Prof. Martin, containing his geological map of New York and vicinity, ex-

tended so as to connect with the Philadelphia rocks. The section does not claim to be an accurate geological section. We have indeed no data yet for that, but it simply shows the order of the rocks, and to some extent the dips, and there is also a hint of the possible structure.

The backbone of the region is the range of Laurentian gneiss which extends from the Delaware at Trenton south-eastward. To the north of this lies the great Chester-Montgomery Valley, of Cambrian and probably Trenton limestone, flanked on the north by the elevated range of Potsdam—the North Valley Hill.

Between the Laurentian and the Chester Valley lies a range, uniformly of hydro-mica schist, from one to three miles broad, known as the South Valley Hill, otherwise Bethel Hill. Between the Laurentian and this South Valley Hill is a narrow valley locally known as Cream Valley; this is not over a half to a quarter of a mile in width, and the exposures of rocks are few and far between, but most interesting.

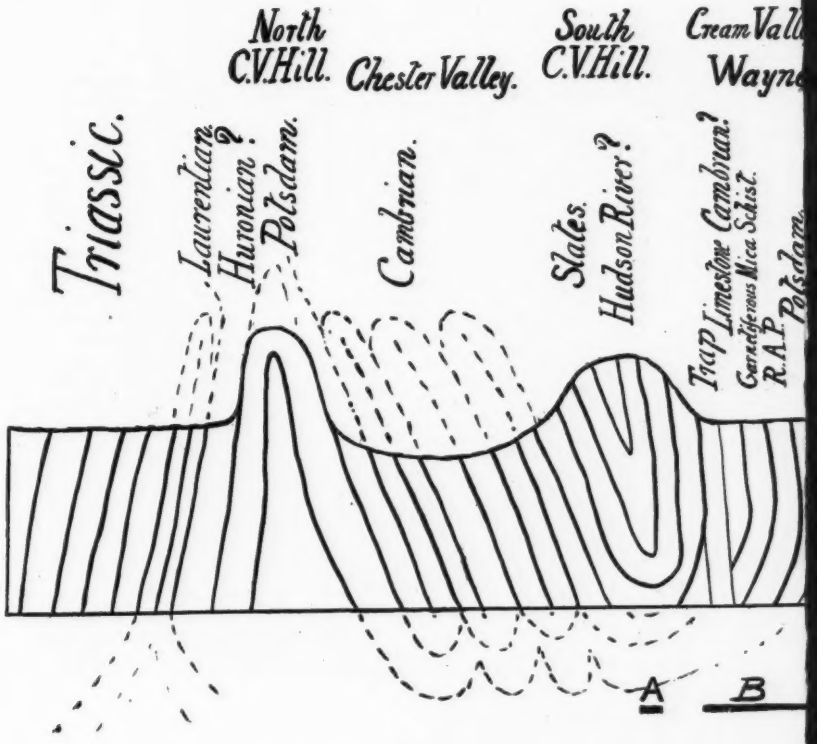
In Cream Valley, north of the Laurentian, occurs at several localities a stratum of feldspathic sandstone with micaceous partings, and more or less rhomboidal fracture, full of minute tourmalines. This rock seems to be absolutely identical with the eurite of Spring Mill and Barren Hill, which lie to the north-eastward, in the same relation to the Laurentian, and which has been identified as Potsdam sandstone. North-west of this Potsdam sandstone is a limestone, two hundred or three hundred feet wide at the mouth of the valley near the Schuylkill River, but only about fifty feet wide, three miles from that stream; this limestone resembles very closely some of that of the Chester Valley (Cambrian), being crystalline, and containing in some layers crystals of pyrites—elongated cubes; the exposures of this limestone are very few and very poor.

In the floor of this valley occurs a mica-schist, at times filled with garnets, and occasionally containing staurolite; at the Schuylkill and also N. W. of West Chester (about twenty miles S. W.), the limestone appears to be within this schist. At Brooks' quarry, near Radnor Station, the rocks bounding the limestone are schistose feldspathic gneiss, but I think this is a local modification of the garnetiferous schist.

In Cream Valley there are also two belts of serpentine. That nearest the Laurentian forms an extensive belt beginning a half mile east of Radnor Station, and extending thence south-westward in a series of outcrops of echelon structure (not continuous, but with no very long breaks), some twenty miles to the Brandywine; this is close to the Laurentian; indeed at Radnor it appears to be entirely within the Laurentian; but in many places there is a garnetiferous schist associated with it. This

NOTE.

From B to C and from F to G, the scale is exaggerated, the true scale being as shown, B C=A=D, and F G=E=H.



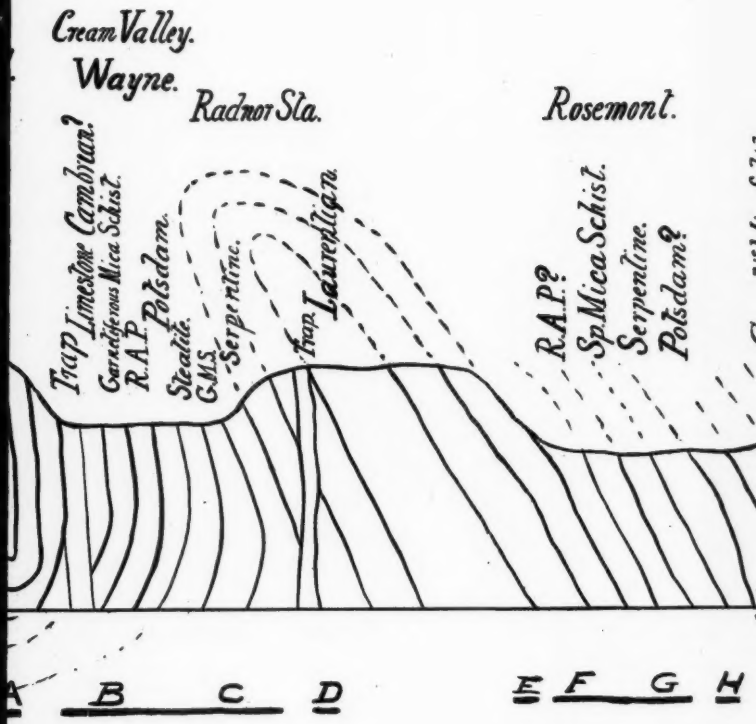
SECTION OF THE

FROM THE

Triassic of Chester Co. to the Creta

On a line about N.W. and S.E. passing thr

BY THEODORE D. R



HE ROCKS

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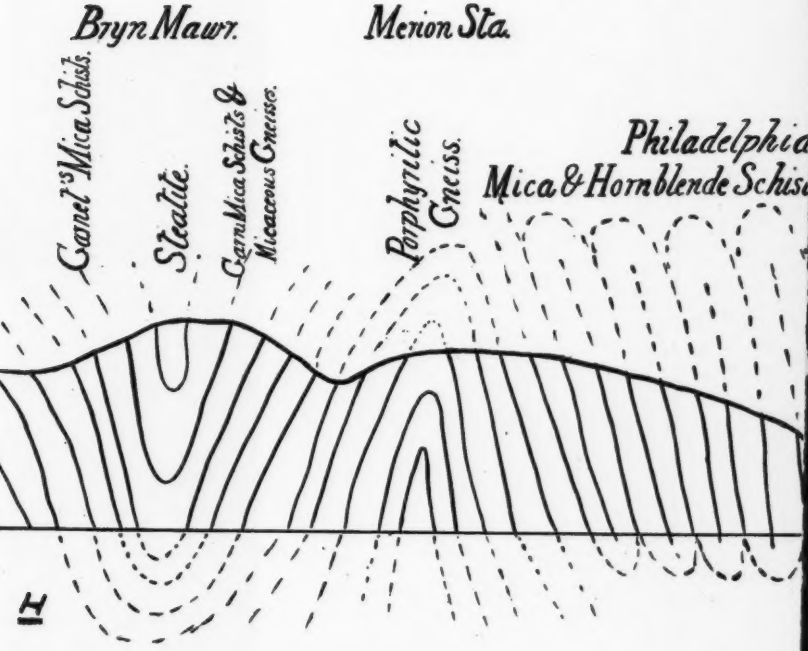
Cretaceous of New Jersey,

ng through Philadelphia, Pa.,

D. RAND.



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1
2
MILES
R.Schuylkill.
R.Delaware.
Cretaceous N.J.

belt is usually a hard, very dark serpentine, containing very few mineral inclosures, and certainly in part an altered enstatite. Five or six hundred feet north of this is a much narrower belt of serpentine rocks containing much steatite. It is about two miles long.

From the position of these rocks it seems indisputable that the garnetiferous schist, as well as the limestone, overlies the Potsdam sandstone; though it is not uncommon to find the dips southerly towards the Laurentian, indicating an overturn.

Turning now to the S. E. side of the Laurentian axis, we find regular south-east dips in the Laurentian, and, adjacent to it, rocks very much like those on the N. W. There are again two serpentine belts; the one nearest the axis is a hard serpentine, accompanied by enstatite, and evidently resulting from its alteration. Beyond this are garnetiferous schists, in which is a bed of serpentine and steatite, apparently an altered schist; it is true that the mica-schists on the east are very extensive, those on the west comparatively narrow; but taken all in all, the resemblance is so great that I think there can be little doubt that the structure is a simple anticlinal.

Mr. Hall regards these serpentines and steatites as all of the same geological age, but if lithological evidences in adjacent localities mean anything, this cannot be true. The hard, dark serpentines are exceedingly unlike the steatite of the two belts farther away from the Laurentian. The constant occurrence of this enstatite serpentine, invariably close to the Laurentian, not only in the region described, but also elsewhere in Pennsylvania, seems to be much more than a coincidence. The steatite belts, on the contrary, are away from the Laurentian, and in the mica and hornblende schists. A remarkable rock associated with the south-easterly steatite belt is a steatite filled with masses of black serpentine, sometimes having the form of staurolite. This occurs in immense quantity through a lineal extent of about five miles. The dark serpentines contain chromite; the steatites, I think, do not. The steatites contain a variety of minerals, the serpentine is almost barren.

Between the serpentine and the Laurentian occurs a rock which, for want of a better name, I have termed spangled mica schist. It is a schist containing mica in curved crystals quite separate one from the other, much resembling the crystals of feldspar in a porphyry. At Darby Creek it is, in fact, a porphyritic gneiss, but elsewhere the feldspar is in very small quantity, and minutely disseminated.

Further eastward, and ranging to the border of the city of Philadelphia, is a very well defined belt of hard porphyritic

gneiss in heavy beds. At the Schuylkill this is very narrow, but it forms the barrier which gave to that part of Philadelphia the name of The Falls. South-westward these rocks widen, until at the Pennsylvania Railroad they are about two and a half miles in width.

I am inclined to regard this as an anticlinal of older rocks, possibly Laurentian, and the schists on each side as overlying it. South-east of this is another belt of the mica-schist extending to Fairmount, and beyond. In all this mica-schist region there are occasional beds of gneiss, sometimes feldspathic, sometimes hornblendic, and varying in hardness between wide extremes.

Many of these beds are quite narrow, others seem extensive, but the rocks vary greatly, even on the line of strike. The Fairmount gneiss, which unquestionably is identical with the gneiss around Chester, in Delaware County, has become well known through its use as a building material, for which it is very well suited, and also because the granite veins, or beds, in these rocks have afforded many varied and interesting minerals, while the mica-schist and the hornblendic gneisses contain almost none.

Apparently underlying this and the other mica-schists and gneisses is a bed of very hard feldspathic gneiss, occasionally hornblendic, but generally micaceous, which appears to be rising on the summit of an anticlinal, the axis of which is E. and W., while the general strike of the region is very constant at N. $\pm 60°$ E. Besides the chief outcrop at Frankford, which has been largely quarried, the same rock undoubtedly outcrops at Wayne Station, Germantown, and on the Wissahickon, near Mt. Airy. This has proved rich in minerals, yielding fine crystals of molybdenite, epidote, stilbite, and apophyllite, besides sphene, biotite, calcite, Heulandite, Randite, Philadelphite, apatite, and fluorite.

In considering the geology of these rocks, we have as fixed points going south-eastward, the Triassic, the Potsdam (of the North Valley Hill), the Cambrian (of Chester Valley), and the Laurentian—and undetermined, the hydromica schist of the South Valley Hill, the rocks of Cream Valley (except the Potsdam), and all the rocks south-east of the Laurentian. Mr. Hall suggested, contrary to the previously accepted theory, that the hydromica schists overlie the limestone, and are of Hudson River age, but the supposed absence of the Potsdam on the south easterly leg of the synclinal was a difficulty. As the Potsdam really exists in that position, with a limestone between it and the hydromica, the probability of Mr. Hall's theory being correct is great. It is true that both the Potsdam and the limestone are very thin and out of all proportion to the outcrops to the north-westward, but as they lie upon the Laurentian

shore of the ancient ocean, such differences of thickness may not be difficult of explanation.

The whole region, like that of New York, is a most difficult one. The rocks are often decomposed to a great depth. Still, with care, certain belts can be traced with almost absolute certainty for miles, but the contacts are concealed in a most exasperating manner. In Cream Valley there are numerous outcrops, but very poor exposures, and while I believe we know all the rocks of the valley, we do not know with certainty even their order of occurrence. The Potsdam is probably between the serpentine and the steatite, but this is not established. The dips are misleading and untrustworthy.

DR. NEWBERRY inquired about the length of the section, and as to the grounds on which the Laurentian and Potsdam had been identified; also as to the thickness of the latter.

MR. RAND replied that the section-scale was four inches to the mile, save in the portions immediately adjacent to the Laurentian, where it had been exaggerated (as shown on the Plate) in order to exhibit the various strata occurring within a narrow belt of a quarter of a mile. The total length across the crystalline belt, from the Triassic to the Cretaceous, is about twenty-five miles. The section-line approximates the course of the Pennsylvania Railroad, until the latter turns toward the S. W. along the northerly side of the South Valley Hill.

As to the identification, the Laurentian has been determined further to the N. W. Its characteristic mineral is an abundant blue quartz. As soon as the area of these rocks is entered upon, the fact is indicated to the eye by the fragments of this bluish quartz in and upon the soil. The rock is further characterized by containing magnetite and zircon.

The Potsdam is found along the same line as here indicated, further to the north, where it contains *Scolithus*. This fossil has not been found in Delaware Co.; but the peculiar rock—a feldspathic sandstone with rhomboidal fracture and micaceous partings, and containing numerous, though usually minute, tourmalines—is almost identical. Its thickness cannot be accurately given; it is between ten and fifty feet.

DR. NEWBERRY inquired further as to the presence of limestones or dolomites, so abundant in the rocks of the New York and Westchester region.

MR. RAND replied that they are not found in the vicinity of Philadelphia, though he had paid less attention to the limestones, and did not like to assert positively. Carbonate of lime occurs in the gneisses and dolomite in the steatites, but rather as a rare mineral, in both cases, than as a constituent.

PROF. D. S. MARTIN spoke with high appreciation of the observations of MR. RAND, and said that he had looked forward to this meeting as one of much importance, hoping that it might mark a new departure in local studies of this kind. All that has been done in the region about this city has been for years past confined principally to local mineralogy. In that department a great deal of interesting work has been accomplished; but the geological relations of our crystalline rocks have received little elucidation. Our Philadelphia brethren seem to have gone further than we have; perhaps because the rocks thereabout are better defined, or more readily accessible, than ours. It is very desirable that some movement for more systematic study should be organized. Why might not a plan be arranged by which local mineralogists and geologists all along the line of this belt of "Atlantic" gneiss should co-operate in the study of its relations? Such a connected scheme of working could hardly fail to yield important results in clearing up the geology of this much disputed region.

DR. N. L. BRITTON expressed his great interest in the results reached and the hypotheses suggested by MR. RAND, which he thought would in the main prove to be correct. He remarked that nearly all the rocks found by MR. RAND and his colleagues in the section described actually occur in the vicinity of New York, although they can nowhere all be seen in so small an area as the one described by MR. RAND. Indeed in the broad Laurentian area of Westchester County there are still additional kinds of metamorphic rock species of no little interest and significance. The serpentines, gneisses, mica-schists and hornblende-schists, and their contents, are evidently very similar, with local differences such as we would naturally expect; there is more serpentine in the Philadelphia region and less crystalline limestone, none of the latter having been mentioned by MR. RAND.

DR. BRITTON regarded all these strata as portions of a single

group of rocks, and had been able to detect no unconformability at any point among them. He thought it probable that most of the crystalline limestone outcrops were actually the same beds brought repeatedly to the surface by the folding, faulting and pitching of the strata. Rocks similar to, if not entirely identical with, the hydromica schists shown by MR. RAND occur in very considerable development about the eruptive masses of Verplanck's Point and Stony Point, where they are evidently altered Palæozoic beds, and such may also be studied along the western margin of the Triassic area at various points in New York and New Jersey.

MR. KUNZ, MR. WM. NIVEN, DR. BRITTON, PROF. MARTIN, DR. FRIEDRICH, and the PRESIDENT continued the discussion on a number of points, comparing the rocks and minerals of New York, Westchester Co. and Staten Island with those described and shown by MR. RAND. A selected series of one hundred typical specimens of Philadelphia rocks had been brought on by MR. RAND, to illustrate his paper. This interesting collection he generously offered to the Mineralogical Section of the Academy, to be retained in New York; and the gift was accepted, with a vote of thanks to the donor.

DR. J. J. FRIEDRICH presented the following:

RESUMÉ OF THE LITHOLOGY OF MANHATTAN ISLAND.

(Nomenclature and classification according to E. Kalkowsky's "Elemente der Lithologie," Heidelberg, 1886.)

Among our local rocks we find representatives of the following eleven groups:

1. Dolomite.
2. Serpentine to Peridotite Group. All varieties found in Staten Island occur here; especially ophiolite, in fine specimens, deserves mention.
3. Talc and Chlorite Group.—Especially a protochlorite schist in contact with pyroxenites.
4. Granulites.—Garnetiferous, amphibolitic, marcasitic, and micaceous.
5. Quartzite.
6. Pyroxenite.
7. Epidote.

8. Amphibolites.—True, garnetiferous, marcasitic, saccharitic, scapolitic; gneiss amphibolite, and epidote amphibolite.

9. Granite.—This granite is sedimentary and not eruptive; so-called "Lagergranite." The varieties are muscovite, biotite, bio-micaceous, tourmalinic, and coarse granite. Pegmatite.

10. Gneiss.—Muscovite, biotite, micaceous, sericitic, albite, amphibolite, epidote, calciferous, garnetiferous, tourmalinic, magnetite, and giant gneiss.

11. Gabbro.—This is found in one locality only—in 100th street, between Lexington and Fourth avenues.

Veins. These consist of quartz, albite, calcite, chabazite, iron ores—limonite, marcasite, and magnetite,—quartzite, coarse granite, pegmatite, and a metamorphosed magma, consisting of the detritus or remnants of epidote and protochlorite schist. The composition of this last class of veins demonstrates plainly the nature of its genesis, having been formed from above or in faults and intervening spaces. These vein-constituents occur individually, or associated with a certain regularity, and accompanied by a specific group of minerals. For instance, chabazite may occur singly, but it is generally associated with quartz, albite, calcite, limonite, and marcasite; these minerals occur massive, but often in beautiful crystals, especially chabazite is represented by all its known varieties good specimens of phacolite are common, and pseudomorphs of limonite after phacolite.

Lithological Belts or Regions:

1. Serpentine. This region is limited between Ninth avenue and the Hudson and between 57th and 60th streets.

2. The dolomite belt is predominant at the northern terminus of the island.

3. The typical New York Island or Gneiss Belt comprises the lower two-thirds of the island. There are only a few varieties missing, and there is scarcely a locality which is more favorable the study of gneisses.

4. Albite, Epidote and Protochlorite Belt, with specific ores (pyrite, pyrrhotite, magnetite [also in crystals], limonite, and ilmenite) and traces of serpentine. The limits are 95th and 102d streets, and Third and Fifth avenues. From this region are specimens of albite and epidote, as fine as those found in the Austrian Tyrol.

Conformability. There is conformability between the gneisses and mica schists, and unconformability between gneiss and serpentine and between mica schists and amphibolites.

Dip. The direction of the dip varies as much as the angle; the bottom rock along the East River between 72d and 42d streets is almost horizontal, while on the west side, between 80th

and 90th streets, and west of Eighth avenue, the angle of the outcropping rocks may be as high as 80° and over.

Rock Scheme. In the Gneiss Belt the layers succeed as follows:

1. Muscovite gneiss (bottom rock); 2. Mica schists and biotite gneiss: 3. Amphibolites and pyroxenites; 4. Pegmatite and granite.

Geological Age. Though lithological study in itself is not sufficient to establish the definite age of a rock, the occurrence of gabbro and of the granulites, taken in connection with the entire absence of any fossils, etc., may justify the conclusion that our island belongs to the upper series of the Archæan age. The quaternary age is represented by moraines, clays, gravel-beds, and in some locations by a soft mica schist, mixed with kaolin, which hardens on exposure, and which unquestionably consists of the rock-meal or detritus, ground down by glacial action. These ancient lake-bottoms are filled in with bowlders and detritus.

PROF. MARTIN stated that the suggestion had been recently made by CAPT. A. W. VOGDES that great advantage might be derived from the passage of a city ordinance requiring that wherever excavations are made by the city, or permits given therefor to individuals or contractors, it should be required that typical specimens of the rock be secured and deposited in some assigned and permanent place, such as the City Hall, the American Museum, or the College of the City of New York. In this way the distribution of rocks throughout at least the upper part of the island might be made a matter of permanent record. He suggested that the Academy should take some action for carrying out this idea of CAPT. VOGDES.

EX-ALDERMAN CONKLING said that he had no doubt that if such an ordinance were proposed, and the reasons for it laid before the Board of Aldermen, there would be no difficulty at all in regard to its adoption.

The suggestion was discussed by several members; and it was voted to appoint a committee to take steps toward securing such an ordinance, the committee to report to the Academy before taking positive action.

Messrs. D. S. MARTIN, GEO. F. KUNZ and W. H. J. SIEBERG were named as the committee.

January 14, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Sixteen persons present.

DR. NEWBERRY exhibited a new mineral, arsenide of platinum, recently described under the name of Sperrylite ($PtAs_2$), occurring in metallic crystalline grains at the Vermilion Mine, Algoma, Canada. He remarked upon the great interest attaching to such a novel compound, and read the description by Mr. H. L. Wells, as published in the *Amer. Journ. Science* for the current month.

MR. GEORGE F. KUNZ referred to other arsenides, especially that of silver, already described.

A paper was read, contributed by MR. JOHN EYERMAN, of Easton, Pa., and entitled:

ON THE MINERALOGY OF THE FRENCH CREEK MINES, PENNSYLVANIA.

At a meeting of the Academy held January 12th, 1885 (TRANS. NEW YORK ACAD. SCI., Vol. IV., p. 41), the late Mr. B. B. Chamberlin read a paper on the minerals of the above locality. As only a few of the minerals were then described, and as these mines have lately produced some wonderful specimens, the writer will endeavor to give a description of all the occurrences at this locality.

The mines are situated on a granite-augitic trap-dyke. The whole mass of trap, although quite narrow at the mines, widens with wonderful rapidity as it proceeds westward. The dyke at the mines is bounded on both sides by the Mesozoic (Jura [?] Trias) red sandstone. Three miles due west, a ridge of Potsdam quartzite outcrops. Three-eighths of a mile due south, and immediately on the south bank of the French Creek, the "Azoic slates" (of Frazer) are noticed. The greatest length of this trap-dyke is nearly eight miles.

There are three shafts, the deepest of which (Shaft No. 1) has worked to a depth of 390 feet. It is about 500 feet from the W. and N. Station. This shaft appears to produce the greatest variety as well as the best developed specimens, the perfect crystals of pyrite and chalcopyrite coming from the 250 feet level in this shaft.

Pyrite occurs associated with the iron ore (magnetite) and with massive calcite. It has been noticed, however, and not without reason, that the best developed and best preserved specimens are found in a massive calcite, which, on account of the dissemination through it of amphibole-byssolite, I prefer to term *byssolitic calcite*; pyrite exists here in many forms, but, unfortunately, on account of the poor development, many have been indeterminable. Some of the planes determined with accuracy are:

1, H(O), 2-2, i, 2-2
i-3, 2, $3\frac{3}{2}$, $\frac{1}{2}$ (i-2)

A few combinations as follows:

O ∧ $3\frac{3}{2}$ O ∧ 2 O ∧ 1
O ∧ i-i 1 ∧ i-2 $\frac{1}{2}$ O ∧ 1

Some perfect cubes were 28 mm. in diam., and octahedrons as large as 45 mm. have been found.

Chalcopyrite occurs in the same shaft and in the same manner as pyrite. It is generally found in single and grouped sphenoids. I have noticed some wonderfully large, perfect single crystals 30 mm. across. The parallelism noticed by Mr. Chamberlin is developed on a grand scale, and I have seen perfect crystals in groups which measured two feet square. I have also noticed a single specimen of chalcopyrite pseudomorphous after pyroxene.

Apophyllite occurs in well-defined, generally modified crystals up to 14 mm. square. Shafts 2 and 3 produce the best specimens. Groups fully as large as the chalcopyrite (2 ft. square) have been taken from the mine.

One of the largest crystals in my possession has the form O, 1, i-i. Other planes are I, i-2; and crystals like Fig. 387 in Dana are frequently met with.

An analysis made last April afforded me

SiO_2	51.63
CaO	25.42
K_2O	6.27
H_2O	16.58
	99.90

Sp. gr. 2.35.

Iron Apophyllite occurs quite abundantly in massive forms; color, light pink.

Stilbite occurs sparingly in shaft No. 1 in crystals, generally of small size, lining cavities and associated with calcite. The i-ī—i-ī prism predominates. The larger crystals are imperfect.

One large crystal measured 35 mm. in length. An analysis resulted as follows:

SiO_2	58.00
Al_2O_3	13.40
Fe_2O_3	tr.
CaO	7.80
MgO	1.40
K_2O	1.03
Na_2O	tr.
H_2O	18.30
	99.93

Calcite assumes a number of forms, and many planes have been noticed, but few definitely determined. It is found in greater or less quantities throughout the mine.

Beautiful specimens of Iceland spar, equal to that from Rossie, N. Y., have been obtained. Another variety is iridescent, also good transparent scalenohedrons of a light-yellow color.

Single rhombohedrons of large size, transparent, and of a dark-yellow color, have occasionally been met with. Some of these rhombs on apophyllite measure 15 mm.

Another interesting form of this species is the variety byssolitic calcite, in which the long acicular crystals of byssolite are disseminated throughout the calcite, giving it a dark-green appearance.

Orthoclase. An interesting variety of orthoclase occurs in shaft No. 1. The crystals are columnar, and radiating from a centre form a sheaf-like structure.

The largest crystals observed were 64 mm. in length; color, light green to light pink.

An analysis by Dr. Genth[1] gave:

Loss by ignition	0.67
SiO_2	62.68
Fe_2O_3	0.23
Al_2O_3	20.90
CaO	0.15
Na_2O	none.
K_2O	15.92
	100.62

Sp. gr. 2.528.

I have found a small percentage of MnO in the green varieties.

Pyroxene occurs both massive and crystallized. It is abun-

[1] Proc. Am. Phil. Soc., xxii., p. 43.

dant in shaft No. 1. The perfect crystals are generally of a dark-green color, and measure from 15 to 42 mm. in length. The planes observed are I, i-i, O.

A variety of pyroxene from the deeper workings is *pyrallolite*, which occurs massive, of a light-pink color; also occasionally radiated.

Amphibole, Byssolite. Besides the common byssolitic calcite there is a more perfect form, in which the calcite has been dissolved, leaving the crystals in beautiful slender needles, many of which are 42 mm. long.

Actinolite also occurs here in radiating crystals.

Erythrite is disseminated throughout the byssolitic rock, and associated with calcite in Shaft No. 1; lustre very dull.

Aragonite occurs at Shaft No. 1, in silky fibres and acicular crystallizations. It is, however, not equal to that from the Jones Mine, a few miles north in Berks County, which is noted for its beautiful aragonite.

Magnetite is found abundantly in small brilliant octahedrons.

Garnets. Lime-iron garnets in dodecahedral crystals of a brownish-black color occur in considerable quantities at Shaft No. 1.

Dana mentions aplome garnets as occurring here, which I think is erroneous, as I have never noticed any striations whatever.

Malachite, *Chrysocolla*, *Bornite* } occur either massive or coating the other minerals, particularly the calcite.

MR. GEORGE F. KUNZ read the following paper:

A REMARKABLE LOCALITY OF AMERICAN FLUORITE.

About four years ago, a small vein of fluor-spar was discovered in the town of Macomb, St. Lawrence Co., N. Y. It was worked from time to time until last summer, when the vein suddenly widened, breaking through into a cavity or cave, which proved to be sixteen feet in length, and ten feet in width at the narrowest part, widening out to fifteen or eighteen feet or more. The top, bottom, and sides were lined with a magnificent sheet of crystals, varying from one to six inches in diameter, each in turn forming part of larger composite crystals. Between the floor and the walls was a layer of partly decomposed calcite, readily removable, so that groups of fluor-spar crystals, weighing from ten to several hundred pounds each, and in one case measuring two by three feet, were easily detached. The cavity contained at least fifteen tons of fluorite.

The habit of the crystals, in almost every instance, is that of

the simple cube, but the faces of the octahedron, slightly developed, are often present. Nearly all the crystals have on the surface, in small botryoidal elevations, an even coating of brown hydrodolomite, which is readily removed with dilute hydrochloric acid. The crystals are all well colored, but the surfaces are dull; the tint is a uniform light sea-green, save at the junction of the crystals, or where they are attached to the gangue. Here there are small spots, from one to two inches in diameter, of a rich emerald green. Attached to the fluorite are small masses of lithomarge, and imbedded in these, very perfect tetrahedral crystals of chalcopyrite.

With the fluorite are found small bunches of pyrite crystals, nearly always altered to limonite. Galenite has not been observed, although this locality is only a mile and a half from the well-known Macomb lead mines. Several years ago, a large quantity of rhombohedral crystals of calcite were obtained here; a number were the size of a man's head, and in form they were generally very simple rhombohedrons.

This "find" is strikingly like that of the famous Muscallonge Lake localities of forty years ago, except that the crystals are of a finer color and in larger groups. The occurrence of a second deposit in this county leads to the inference that fluorite may exist in commercial quantity for the arts.

January 21, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

PROF. D. S. MARTIN, in behalf of the Publication Committee, presented the first and second numbers of Vol. VIII. of the Academy's TRANSACTIONS, just issued, and also the programme and cards for the public lecture-course of the present season, announcing the following schedule :

I. JANUARY 28TH.—Volcanoes: their Distribution and Phenomena.
PROF. DARWIN G. EATON, of Brooklyn.

II. FEBRUARY 11TH.—Modes of Evolution in Fossil Shells.
PROF. ALPHEUS HYATT, of Boston.

III. MARCH 4TH.—Diffraction of Sound.
PROF. W. LECONTE STEVENS, of Brooklyn.

IV. MARCH 25TH.—The Little Builders of the Earth.
REV. E. C. BOLLES, of New York.

V. APRIL 15TH.—Glacial Moraines in the Front Range, Col.
MR. FREDERICK H. CHAPIN, of Hartford.

DR. N. L. BRITTON then described a collection of plants made by DR. E. A. MEARNS in Arizona, illustrating it with a large and interesting series of mounted specimens.

DR. HENRY H. RUSBY followed with a description of the botanical characters of the region whence Dr. Mearns' collection was obtained; these two papers, constituting the programme for the evening, were as follows:

A LIST OF PLANTS COLLECTED AT FORT VERDE AND VICINITY AND IN THE MOGOLLON AND SAN FRANCISCO MOUNTAINS, ARIZONA, 1884–1888, BY DR. E. A. MEARNS, U. S. A.

(With description of new species.)

BY N. L. BRITTON.

The collections here enumerated were sent by Dr. Mearns to the American Museum of Natural History, and were thence referred to me for determination by Mr. L. P. Gratacap. A complete set exists at the Museum, and another nearly complete one has been placed in the Herbarium of Columbia College. A few duplicates have been distributed.

It is to be hoped that Dr. Mearns will continue his botanical explorations; for in the recesses of the mountains of this portion of Arizona there doubtless occur other species and varieties as yet unknown to science. It is not likely that the following list contains the names of more than one-third of the plants which are to be found in the district. Dr. Rusby's account of the general floral features of the country, written from studies made by him in 1881–1882, at the time he made his very extensive gatherings which contain so much that is novel and interesting, wil forcibly supplement my bare cataloguing of the species.

RANUNCULACEÆ.

Anemone cylindrica, Gray. Baker's Butte (51).
Anemone decapetala, L. San Francisco Mts. (15).
Thalictrum Fendleri, Engelm. Baker's Butte. (16).
Ranunculus affinis, R. Br. Mogollon Mts. and east slope of San Francisco Mts. (90 and 17).

Ranunculus Arizonicus, Lemmon, var. *subsagittatus*, Gray. Baker's Butte (75 *and* 76).
Aquilegia Canadensis, L. Flagstaff (157).
Aquilegia chrysantha, Gray. Little Squaw Peak (144); Baker's Butte (87); Clark's Valley (20).
Delphinium scopulorum, Gray. Baker's Butte, (256).
Delphinium scaposum, Greene. Fort Verde (255).

BERBERIDEÆ.

Berberis repens, Lindl. Baker's Butte (83).
Berberis Fremonti, Torr. Fort Verde (266).

PAPAVERACEÆ.

Platystemon Californicus, Benth. Fort Verde (205).
Eschscholtzia Mexicana, Greene. Fort Verde (192).
Corydalis aurea, Willd., var. *occidentalis*, Gray. Fort Verde (172 and 305).

CRUCIFERÆ.

Streptanthus cordatus, Nutt. Fort Verde (269).
Cardamine cordifolia, Gray. Fort Verde (293).
Lesquerella Fendleri (Gray), Wats. Fort Verde (310).
Physaria Newberryi, Gray. A form with short style and bunched inflorescence, associated by Dr. Watson with specimens collected by Matthews in western Texas. Crater Butte, east of San Francisco Peaks (28).
Sisymbrium canescens, Nutt. Fort Verde (336). I have elsewhere followed Professor Greene in the use of the name *pinnatum* for this species. But there is already a *S. pinnatum*, Barneoud in Gay, Flor. Chil. i. 125 (1845), rendering Walter's earlier *Erysimum pinnatum* unavailable for the plant.
Erysimum lanceolatum, Pursh. (*E. asperum*, DC). The *E. lanceolatum* R. Br., which as a binomial antedates Pursh's by two years, has a variety of older specific names, and is referred by Koch in Syn. Flor. Germ. and Helv. to *E. Cheiranthus* Pers., which leaves the name adopted here as valid for the species. Fort Verde (149 and 315).
STANLEYA PINNATA (Pursh). *Cleome pinnata*, Pursh, Flor. Amer. Sept. ii. 739 (1814); *S. pinnatifida*, Nutt., Genera, ii. 71 (1818). Originally described as *Cleome*, it has much in common with that genus. Fort Verde (280).
Lepidium alyssoides, Gray. Fort Verde (309).
Biscutella Wislizeni (Engelm.), Wats. Fort Verde (270 and 341).
Thlaspi alpestre, L. San Francisco Mountains (34).

CAPPARIDEÆ.

Cleome lutea, Hook. Fort Verde (196).
Cleome serrulata, Pursh, Flor. Bor. Amer. ii. 441 (1814); *C. integrifolia*, T. & G., Flora N. A. i. 122 (1838). Fort Verde (195).

VIOLARIEÆ.

Viola palmata, L., var. *cucullata* (Ait.), Gray. San Francisco Mountains (7).
Viola pedatifida, Don. Mogollon Mountains (44).
Viola Nuttallii, Pursh. Fort Verde (291).
Viola Canadensis, L., var. SCARIOSA, Porter, *n. var.* Stipules scarious, 0.2–0.8 in. long, very prominent about the base of the stem and much larger than those of the eastern plant; flowers much smaller. Western base of the San Francisco Mountains (19); Mehren's Ranch, Mogollon Mountains (94). With this I would associate a specimen collected by Dr. Newberry at Lake City, Col., in 1881.

POLYGALEÆ.

Polygala Rusbyi, Greene. Fort Verde (323).
Polygala alba, Nutt. Fort Verde (327).
Krameria parvifolia, Benth. Fort Verde (259).

CARYOPHYLLEÆ.

Silene Thurberi, Wats. Near Fort Verde (72).
Silene laciniata, Cav. Rim Rock, Tonto Basin (137).
Arenaria Rusbyi, Greene. Bloody Basin, between Forts Verde and McDowall (339).

HYPERICINEÆ.

Hypericum formosum, H. B. K. Baker's Butte, Mogollon Mts. (99).

PORTULACEÆ.

Portulaca parvula, Gray. Fort Verde (254).

TAMARISCINEÆ.

Fouquiera splendens, Engelm. Squaw Peak (173).

MALVACEÆ.

Sidalcea Neo-Mexicana, Gray. Mogollon Mts. (64).
Anoda hastata, Cav. Copper Cañon (185).

Sida lepidota, Gray. Fort Verde (191).
Sphæralcea Munroana (Dougl.), Spach. Fort Verde (150 and 225).

LINEÆ.

Linum aristatum, Engelm.? Specimens in flower, the corolla 2 cm. wide, with a dark centre; styles capitate. Fort Verde (314).
Linum perenne, L. Fort Verde (268).
Linum Neo-Mexicanum, Greene. Mogollon Mountains (68).

ZYGOPHYLLEÆ.

Tribulus grandiflorus (Torr.), Wats. Fort Verde (170).
Tribulus maximus, L. Bloody Basin, 42 miles southwest of Fort Verde (333).
Larrea Mexicana, Moric. Fort Verde (181).

GERANIACEÆ.

Geranium Richardsonii, Fisch. & Meyer. Mogollon Mountains (89).
Geranium cæspitosum, James. Mogollon Mountains (104).
Erodium cicutarium (L.), L'Her. Fort Verde (304).
Oxalis divergens, Benth. Baker's Butte, (112).
Oxalis corniculata, L. San Francisco Mountains (31).

RUTACEÆ.

Canotia holacantha, Torr. Fort Verde (242).
Ptelea augustifolia, Benth. Fort Verde (209 and 294).

CELASTRINEÆ.

Pachystima Myrsinites (Pursh), Raf. Weber Creek, Tonto Basin (140).

RHAMNEÆ.

Rhamnus Californica Esch., var. *tomentella* (Benth.), Brew. and Wats. Tonto Basin.
Ceanothus Greggii, Gray. Fort Verde.
Ceanothus Fendleri, Gray. Mogollon Mts. (122).

SAPINDACEÆ.

Negundo aceroides, Mœnch. Verde River (207).

ANACARDIACEÆ.

Rhus aromatica, Ait., var. *trilobata* (Nutt.), Gray. Fort Verde (328).

Rhus glabra, L. Fossil Creek. (272).

LEGUMINOSÆ.

Thermopsis montana, Nutt. Baker's Butte (80).

Lupinus argenteus, Pursh. San Francisco Mts. (21); Baker's Butte (74); Bishop's Creek (343).

Melilotus Indica (L.), All. Fort Verde (324).

Trifolium involucratum, Willd. Mogollon Mts. (53).

HOSACKIA MEARNSII, *n. sp.* Perennial, herbaceous, densely silky canescent all over; stems branched, 6–8 inches high; leaves 3–5-foliolate, petioles short; leaflets obovate-cuneate, obtuse or even truncate at the apex, one-quarter inch long, three-eighths inch wide, stipules very minute and gland-like; peduncles slender, about two inches long, two to four flowered; flowers three-fourths of an inch long, orange-red and showy, pod silky canescent, about the length of the flowers, tipped with the smooth, persistent style, which is over an eighth of an inch long, and in some cases has the stigma still remaining. Fort Verde (342).

Hosackia puberula, Benth. Fort Verde (295).

Hosackia Wrightii, Gray. Fort Verde (262); Baker's Butte (91).

Dalea formosa. Torr. Fort Verde (11).

Robinia Neo-Mexicana, Gray. Mogollon Mts. (129).

Astragalus candicans, Greene. Fort Verde (297).

Astragalus decumbens (Nutt.), Gray. Bishop's Creek (350).

Astragalus Missouriensis, Nutt. Fort Verde (345).

Astragalus Nuttallianus, DC. Fort Verde (335).

Astragalus Pattersoni, Gray? Fort Verde (154, 163 and 303).

Vicia Americana, Muhl. Little Squaw Peak (146); Baker's Butte (98).

Lathyrus decaphyllus, Pursh. (*L. polymorphus*, Nutt.). Fort Verde (167).

LATHYRUS ARIZONICUS, *n. sp.* Glabrous throughout; stems slender, angular, less than a foot long; leaflets one or two pairs, sessile, or nearly so, linear-lanceolate, one to two inches long, one-quarter inch wide, entire, venose, especially below; stipules ovate, acuminate, about one-quarter inch long, peduncles one or two flowered, one inch long; flowers half an inch long, white. Summit of mountain, north of wagon-pass over Mogollon Mountains at Mehren's Ranch. May 27, 1887 (57).

Cologania longifolia, Gray. Mogollon Mts. (107).

Phaseolus Wrightii, Gray. Apparently this species. Baker's Butte (231).
Hoffmanseggia drepanocarpa, Gray. Fort Verde (197).
Prosopis juliflora, DC. Fort Verde (353).
Cassia bauhinioides, Gray. Fort Verde (229).
Calliandra reticulata, Gray. Fort Verde (139).

ROSACEÆ.

Spiræa discolor, Pursh. Clear Creek, near Fort Verde (248).
Geum strictum, Ait. Baker's Butte (59).
Fragaria Virginiana, Duschesne. Mogollon Mts. (71).
Potentilla fruticosa, L. Mogollon Mts. (243).
Potentilla Thurberi, Gray. Mogollon Mts. (50). This is the very silky form of the species, with large flowers, the same as Dr. Rothrock's No. 399 from Mt. Graham, and Dr. Rusby's No. 128, also from the Mogollons. Dr. Mearns collected other specimens, the exact locality uncertain, which are smoother and smaller-flowered, much more nearly resembling the originals of Thurber and Henry. This silky form from the higher mountains may, perhaps, best be separated as a variety.
Geum Rossii, Ser. Mogollon Mts. (101).
Rosa Fendleri, Crèpin. Baker's Butte (82).
Amelanchier alnifolia, Nutt. Mormon Dairy Mt. (42); Ft. Verde (329).

SAXIFRAGEÆ.

Saxifraga nivalis, L. ? San Francisco Mts., altitude 12,000 ft. (26).
Heuchera rubescens, Torr. var. *nana*, Gray. Pl. Wright. ii. 64. I think it probable that this will eventually prove to be a distinct species. Dr. Torrey has expressed that opinion on the label of the Mexican Boundary Survey collection in his herbarium. Rim Rock, Tonto Basin (138).
Fendlera rupicola, Engelm. and Gray. Ft. Verde (298).
Ribes aureum, Pursh. Fort Verde (299).
Ribes Cynosbati, L. San Francisco Mts. (131).

CRASSULACEÆ.

Cotyledon Nevadensis, Wats. ? Bloody Basin, between Forts Verde and McDowall (338).

ONAGRARIEÆ.

Epilobium spicatum, Lam. Baker's Butte (62).
Œnothera biennis, L. var. *grandiflora* (Ait.), Lindl. Mogollon Mts. (47).

Œnothera scapoidea, Nutt. Fort Verde (311).
Gaura coccinea, Nutt. Base of Little Squaw Peak (145); Fort Verde (347). Dr. Mearns remarks that this is a great "bee-plant."
Œnothera speciosa, Nutt. Fort Verde (330).

LOASEÆ.

Mentzelia albicaulis, Dougl. Fort Verde (278).
Mentzelia Wrightii, Gray. Fort Verde (240).

CUCURBITACEÆ.

Cucurbita fœtidissima, Kunth. Fort Verde (325).
MICRAMPELES GILENSIS (Greene). (*Echinocystis Gilensis*, Greene, Bull. Cal. Acad. Sci. i. 189). Fort Verde (165).

UMBELLIFERÆ.

Ligusticum montanum, Gray. San Francisco Mts. (35); Mogollon Mts. (103) purple-flowered forms; Fort Verde, a white-flowered form (307).
Carum Gairdneri (Nutt.), Anderson. Mogollon Mts. (54).
Cymopterus montanus, T. and G. var. *purpurascens*, Gray. Fort Verde (153).

CORNACEÆ.

Cornus stolonifera, Michx. Baker's Butte (106).

CAPRIFOLIACEÆ.

Sambucus racemosus, L. Mogollon Mts. (27).
Lonicera ciliosa (Pursh), Poir. Mogollon Mts. (244).
Lonicera involucrata (Richards.), Banks. Mogollon Mts. (29).

RUBIACEÆ.

Houstonia angustifolia, Michx. A small form. Baker's Butte (115).
Houstonia Wrightii, Gray. Baker's Butte (52).

VALERIANEÆ.

Valeriana edulis, Nutt. Mogollon Mts. (65).
Valeriana sylvatica, Banks. Western base of San Francisco Mountains (12).
Valeriana Arizonica, Gray. Mogollon Mts. (95).

COMPOSITÆ.

Brickellia grandiflora (Hook.), Nutt., var. *petiolaris*, Gray. Fort Verde (233).
Brickellia baccharidea, Gray. Fort Verde (180).
Gutierrezia Sarothræ (Pursh), Brit. & Rusby. Fort Verde (194 and 261).
Solidago Canadensis, L. Fort Verde (263).
Solidago Missouriensis, Nutt. Tonto Basin (143).
Aster foliaceus Lindl., var. *Burkei*, Gray. Near Fort Verde (276).
Aster spinosus, Benth. Fort Verde (212).
Aster canescens, Pursh. Fort Verde (148, 217 and 223).
Erigeron macranthus, Nutt. Fort Verde (232).
Antennaria dioica (L.), Gærtn. Mogollon Mts. (96).
Var. *congesta*, DC., Allen's Park, Mogollon Mts. In grassy parks within the pine forests (40). This would appear from the present specimens to be specifically distinct, but intermediate forms are reported to occur.
Melampodium cinereum, DC. Fort Verde (190 and 308).
Parthenium incanum, H. B. K. Fort Verde (178).
Ambrosia aptera, DC. Copper Cañon (234).
Xanthium Canadense, Mill. Fort Verde (220).
Zinnia grandiflora, Nutt. Fort Verde (239).
Sanvitalia Aberti, Gray. Copper Cañon (182).
Rudbeckia laciniata, L. Baker's Butte (77).
Wyethia Arizonica, Gray. Crater Butte (24); Baker's Butte (116).
Encelia Californica, Nutt. Fort Verde (321).
Verbesina encelioides (Cav.), Benth. & Hook. in Gray, Syn. Flor. Gam. i. 288. Fort Verde (221).
Coreopsis tinctoria, Nutt. Natural Bridge, Tonto Basin (267).
Chænactis stevioides, H. & A. Fort Verde (317).
BAHIA DISSECTA (Gray). *Amauria (?) dissecta*, Gray. Mem. Amer. Acad. iv. 104 (1849); *Villanova chrysanthemoides*, Gray, Smithsonian Contr. v. 96 (1853); *Bahia chrysanthemoides*, Gray, Proc. Amer. Acad. xix. 28 (1883). Copper Cañon. A form with involucral scales not acuminate (183).
Hymenatherum acerosum (DC.), Gray. Fort Verde (189).
Hymenatherum pentachætum, DC. Fort Verde (175).
Pectis Rusbyi, Greene. Copper Cañon (184).
Helenium Hoopesii, Gray. San Francisco Mts. (14).
Gaillardia aristata, Pursh. Fort Verde (322).
Achillea Millefolium, L. Baker's Butte (88).
Baileya pleniradiata, Harv. & Gray. Fort Verde (177).
Senecio Rusbyi, Greene. Baker's Butte (275).

Senecio Thurberi, Gray. East slope of San Francisco Mts., altitude 11,500 ft. (25).
Senecio Neo-Mexicanus, Gray. Squaw Peak, near Fort Verde (171).
Specimens collected at Mehren's Ranch, Mogollon Mts., are also referred to this species with some hesitation.
Senecio Douglasii, DC. Cherry Creek (346).
Cnicus Neo-Mexicanus, Gray. Cherry Creek (340).
Perezia nana, Gray. Fort Verde (236).
Malacothrix Fendleri, Gray. Fort Verde (316).
Calycoseris Wrightii, Gray. Fort Verde (202).

LOBELIACEÆ.

Lobelia splendens, Willd. Fort Verde (273).

ERICACEÆ.

Arctostaphylos tomentosa (Pursh), Dougl. Tonto Basin (334).
Pyrola picta, Smith. Mogollon Mts. (85).
Chimaphila umbellata (L.), Nutt. Tonto Basin (136).

MONOTROPEÆ.

Pterospora andromedea, Nutt. Baker's Butte (130).
Hypopitys Monotropa, Crantz. Baker's Butte (100).

PRIMULACEÆ.

Primula Parryi, Gray. San Francisco Mts. (5).
Androsace septentrionalis, L. Clark's Valley, Mogollon Mts. (126).
Steironema lanceolatum (Walt.), Gray, var. *hybridum* (Michx.), Gray. Baker's Butte (70).

APOCYNACEÆ.

Amsonia Palmeri, Gray. Fort Verde (152).
Apocynum androsæmifolium, L., Mogollon Mts. (48).

ASCLEPIADEÆ.

Asclepiodora decumbens (Nutt.), Gray. Fort Verde (166).
Asclepias Mexicana, Cav. Fort Verde (235).
Asclepias brachystephana, Engelm. Fort Verde (169).
Asclepias tuberosa, L., Mogollon Mts. (123).
Philibertia viridiflora (Torr.), Brit. & Rusby. Fort Verde (238).

GENTIANEÆ.

Erythræa calycosa, Buckl. Fort Verde (226).
Frasera speciosa, Dougl. Mogollon Mts. (245).

POLEMONIACEÆ.

Phlox Douglasii, Hook. Fort Verde (296).
Gilia aurea, Nutt. Fort Verde (204).
Gilia floribunda, Gray. Fossil Creek (249).
Gilia floccosa, Gray. Fort Verde (247).
Gilia inconspicua, Dougl., var. *sinuata* (Dougl.), Gray. Fort Verde—a form with very large flowers, the corolla-tube yellowish and the limb purple (201).
Collomia aggregata (Pursh), Torr. Mogollon Mts. (49); Copper Cañon (187).
Polemonium confertum, Gray. San Francisco Mts. (36). Agassiz Peak (102).
Polemonium flavum, Greene. Cañon of Clear Creek, fifty miles from its confluence with the Rio Verde (160).

HYDROPHYLLACEÆ.

Phacelia crenulata, Torr. Fort Verde (260 and 313).

BORAGINEÆ.

Mertensia lanceolata (Pursh), DC. San Francisco Mts. (6).
Mertensia paniculata (Ait.), Don. Cañon of Clear Creek (162).
Onosmodium Thurberi, Gray. Cañon of Clear Creek (161).
Lithospermum multiflorum, Torr. Baker's Butte (81).

CONVOLVULACEÆ.

Ipomœa coccinea, L. Fort Verde (230).
Ipomœa Mexicana, Gray. Fort Verde (262).
Ipomœa costellata, Torr. Copper Cañon (274).
Convolvulus sepium, L. Flagstaff (158).
Convolvulus incanus, Vahl. Fort Verde (211),
Cuscuta arvensis, Beyrich ? Fort Verde (222).

SOLANACEÆ.

Chamæsaracha Coronopus (Dunal), Gray. Fort Verde (214).
Datura meteloides, DC. Fort Verde (271).
Lycium pallidum, Miers. Fort Verde (349).

SCROPHULARINEÆ.

Maurandia antirrhinæflora, Wild. Copper Cañon (186).
Pentstemon barbatus (Cav.), Nutt. Baker's Butte (79); Fort Verde (257); also a scapose form from Mogollon Mts. (114).
Pentstemon Palmeri, Gray. Beaver Creek (200).
Pentstemon spectabilis, Thurb. Fort Verde (292).
Mimulus luteus, L. Fort Verde (290 and 320).
Castilleia pallida (L.), Kunth, var. ACUMINATA (Pursh). *Bartsia acuminata*, Pursh, Fl. Amer., Sept. ii., 429 (1814); *C. septentrionalis*, Lindl. Bot. Reg. t. 925 (1824). Mogollon Mts. (60).
Castilleia parviflora, Bong. Squaw Peak (147).
Castilleia linariæfolia, Benth. Tonto Basin (241).
Castilleia affinis, H. & A. Fort Verde (252).
Castilleia integra, Gray. Fort Verde (61).
CASTILLEIA GLORIOSA, *n. sp.* Perennial; calyx nearly equally cleft; stem about one foot high, puberulent, as are the narrowly linear leaves; bracts very large (2 in. long by 1 in. broad, vivid scarlet, obovate-spatulate, obtuse, strongly three-nerved at the base, entire, or with one or two lobes; corolla 1.5–2 in. long, its lip short, three-lobed. Fort Verde (208). Allied to *C. integra*, of which it may possibly be an extraordinarily showy variety.
Orthocarpus purpurascens, Benth., var. *Palmeri*, Gray. Fort Verde (193).

OROBANCHACEÆ.

Aphyllon fasciculatum (Nutt.), Gray. Fort Verde (286); Bloody Basin (332).
Aphyllon Ludovicianum (Nutt.), Gray (?) Bloody Basin (343).

PEDALINEÆ.

Martynia fragrans, Lindl. Fort Verde (215).

VERBENACEÆ.

Verbena bipinnatifida, Nutt. Flagstaff (159).

LABIATÆ.

Monarda fistulosa, L., var. *mollis* (L.), Benth. Mogollon Mts. (86).
Lophanthus urticifolius, Benth. Baker's Butte (118).
AUDIBERTIA MEARNSII, *n. sp.* Inflorescence glomerate, capitate; bracts scarious, reticulated, purplish, the larger broadly ovate, the smaller cuneate ovate, the two lower nearly orbicular and persistent; calyx scarious, about half an inch long,

its four nearly equal lobes minutely ciliate, leaves cinereous, clavate-linear, thick, obtuse, quite entire, about three-quarters of an inch long. Related to *A. capitata*. Fort Verde (246). A curious feature of the species is the prolification of the floral axis in all the specimens examined.

Brunella vulgaris, L. Baker's Butte (105).

PLANTAGINEÆ.

Plantago Patagonica, Jacq. A form. Fort Verde (199).

NYCTAGINEÆ.

Mirabilis multiflora (Torr.), Gray. Fort Verde (176).
Allionia incarnata, L. Fort Verde (216).
Bœrhaavia spicata, Choisy. A variety. Fort Verde (218).
Bœrhaavia lasiolena, Torr. Fort Verde (198).
Oxybaphus angustifolius, Sweet. Baker's Butte (253).

AMARANTACEÆ.

Amarantus Wrightii, Wats. Fort Verde (277).

CHENOPODIACEÆ.

Eurotia lanata (Pursh), Moq. Fort Verde (188).

POLYGONACEÆ.

Eriogonum Abertianum, Torr. Fort Verde (224). Named by Dr. Parry.
Eriogonum microthecum, Nutt. Fort Verde (219).
ERIOGONUM MEARNSII, Parry, *n. sp.* Fruticose, with loose, shreddy bark on the older stems, lanose on the growing shoots; leaves crowded, fasciculate in the axils, usually developing short leafy branches, linear, cuspidate, 5–7 mm. long, revolute to a close cylinder, the smooth upper surface concealing the tomentose under, the base terminating in a short membranous expansion, remaining as a scale after the fall of the leaf; inflorescence terminating the upper branches, sparsely corymbose by simple dichotomous extension; involucre pedunculate, 3 mm. high, segments 5, short, connected by a membranous expansion; perianth conspicuous, bright pink or whitish, with prominent midnerves, tube short, segments broadly spatulate, unguiculate, outer broader and spreading, overlapping the inner; stamens shorter than the perianth lobes, filaments hairy, ciliate; bracteoles plumose, longer than the pedicels; akenes narrowly winged, with long projecting

styles; embryo not seen. Fort Verde (179). Though exhibiting some diverse characters, to be included in Section *Corymbosæ*, Benth.

Polygonum Bistorta, L. Mogollon Mts. (84).

POLYGONUM EMERSUM (Michx.), *P. amphibium*, L., var. *emersum*, Michx. Flor. Bor. Amer. i. 240 (1803); *P. coccineum terrestre*, Willd. Enum. 428 (1809); not *P. amphibium*, var. *terrestre*, Willd. Sp. Pl. ii. 443 (1799); *P. amphibium*, var. *Muhlenbergii*, Meisn. in DC. Prodr. xiv. 116 (1856); *P. Muhlenbergii*, Wats. Proc. Amer. Acad. xiv. 295 (1879). *P. terrestre*, B. S. P. in Prel. Cat. Plants N. Y. (1888). Rattlesnake Forks, Mogollon Mts. (93).

RUMEX ARIZONICUS, *n. sp.* Stem smooth, striate, a foot or more high; leaves a foot long, obovate-spatulate, tapering very gradually into the elongated and narrowly margined petiole, the apex abruptly acuminate, slightly scabrous on both surfaces; lower sheaths more than 0.8 in. long, membranaceous; inflorescence spicate in the upper axils, dense; perianth of three smaller outer and three larger inner sepals; stamens six, filaments very short. Fruit not seen. Species probably to be associated with *R. hymenosepalus*, but with very different foliage. Fort Verde (300).

Oxyria digyna (L.), Campd. San Francisco Mts. (33).

LORANTHACEÆ.

Arceuthobium cryptopodum, Engelm. Baker's Butte, on pine (113).

Phoradendron flavescens (Pursh), Nutt. Fort Verde, on cottonwood (164). A variety.

PLATANACEÆ.

Platanus Wrightii, Wats. Beaver Creek (352).

EUPHORBIACEÆ.

Euphorbiaa lbomarginata, T. & G. Near Fort Verde (206).

Euphorbia glyptosperma, Engelm. Fort Verde (155). Named by Dr. C. F. Millspaugh.

Euphorbia Palmeri, Engelm. (?) Western base of San Francisco Mts. (13).

Croton Texensis (Kl.), Muell., Arg. Fort Verde (213).

CUPULIFERÆ.

Quercus undulata, Torr. var. *Wrightii*, Engelm. Tonto Basin (142).

SALICINEÆ.

Salix rostrata, Richards. San Francisco Mts. (3).
Salix nigra, Marsh (?) Fort Verde (302 and 326).
Populus Fremonti, Wats. Fort Verde (174).

GNETACEÆ.

Ephedra Nevadensis, Wats. Copper Cañon (331).

CONIFERÆ.

Juniperus communis, L. San Francisco Mts. (288).
Juniperus Virginiana, L. Near Flagstaff (287).
Juniperus pachyphlœa, Torr. Mogollon Mts. (289).
Pinus monophylla, Torr. & Frem. Mogollon Mts. (285).
PSEUDOTSUGA TAXIFOLIA (Lamb.), (*Pinus taxifolia*, Lamb., Gen. Pinus, i. 51 (1803); *P. Douglasii*, Lamb., op. cit. iii. 163; *Pseudotsuga Douglasii*, Carr.). Baker's Butte (351).

ORCHIDEÆ.

Coralorhiza multiflora, Nutt. Baker's Butte (43); San Francisco Mts. (4).
Goodyera Menziesii, Lindl. Baker's Butte (132).
CALYPSO BULBOSA (L.), *Cypripedium bulbosum*, L. Sp. Plant. 1347 (1753); *Calypso borealis*, Salisb. Parad. Lond. t. 89 (1807).
Epipactis gigantea, Dougl. Fort Verde (168).
Habenaria Thurberi, Gray (?) Weber Creek, Tonto Basin (133).

IRIDEÆ.

Iris Missouriensis, Nutt. Near Flagstaff (156).
Sisyrinchium Arizonicum, Rothr. Baker's Butte (66).
Sisyrinchium bellum, Wats. Baker's Butte (46).

LILIACEÆ.

Unifolium sessilifolium (Nutt.), Greene. Mogollon Mts. (97). Clark's Valley (1).
UNIFOLIUM RACEMOSUM (L.) *Convallaria racemosa*, L.; *Smilacina racemosa*, Desf. Rim Rock, Tonto Basin (134).
Disporum trachycarpum (Wats.), Benth. & Hook. Mormon Dairy Mt. (41 and 69).
Brodiæa capitata, Benth. Fort Verde (301).
Allium mutabile, Michx. Tonto Basin (135).

Calochortus Gunnisoni, Wats. Baker's Butte (108).
Calochortus Nuttallii, T. & G. Fort Verde (203); No. 258 is also, perhaps, this species.
Yucca angustifolia, Pursh. Fort Verde (348).
Yucca baccata, Torr. Fort Verde (337).
Zygadenus elegans, Pursh. Mogollon Mts. (63); Baker's Butte (92).

COMMELINACEÆ.

Tradescantia tuberosa, Greene. Fort Verde (251).
Commelina dianthifolia, DC. Baker's Butte (237).

JUNCACEÆ.

Juncus xiphioides, E. Meyer. Fort Verde (227).
Luzula spadicea, DC. San Francisco Mts. (8).

CYPERACEÆ.

Cyperus speciosus, Vahl. Fort Verde (228).
Eleocharis palustris (L.), R. Br. Fort Verde (265).

GRAMINEÆ.

Panicum Crus-Galli, L. Fort Verde (264).
Phleum alpinum, L. Mogollon Mts. (55).
Eremochloë Kingii, Wats. Fort Verde (210).
Poa Californica, Vasey. East base of San Francisco Mts. (9). Named by Dr. Vasey.
Poa —— (?) San Francisco Mts. (10).
Elymus Sitanion, Schultes. Fort Verde (318).

FILICES.

Polypodium vulgare, L. Baker's Butte (78); Rim Rock, Tonto Basin (109).
Pteris aquilina, L. Baker's Butte (45).
Adiantum Capillus Veneris, L. Fossil Creek (281).
Pellæa atropurpurea (L.), Link. Mogollon Mts. (121).
Pellæa Wrightiana, Hook. Mogollon Mts. (67); Sycamore Creek (344).
Cheilanthes Fendleri, Hook. East of Fort Verde (284).
Asplenium Trichomanes, L. Tonto Basin (110).
Aspidium Filix-mas, L. Cañon of Clear Creek, fifty miles from its confluence with the Rio Verde (127).
Woodsia Mexicana, Fee. Baker's Butte (120).

EQUISETEÆ.

Equisetum robustum, A. Br. Fossil Creek (250).
Equisetum palustre, L. Clark's Valley (125).

MUSCI.

Hypnum rusciforme, Weis. Fossil Creek (282, 283).

GASTEROMYCETES.

Lycoperdon atropurpureum, Vitt. Named by Mr. Chas. H. Peck. Mogollon Mts. (37).

GENERAL FLORAL FEATURES OF THE SAN FRANCISCO AND MOGOLLON MTS. OF ARIZONA AND NEW MEXICO, AND THEIR ADJACENT REGIONS.

BY H. H. RUSBY, M.D.

The territory here considered comprises three distinct regions—an elevated, open, somewhat barren table-land; a still more elevated heavy forest belt, and a low, desert, mostly sandy plain.

The first comprises the northern and north-eastern portions, and is the continuation of the high plateaus of New Mexico and Utah. It is traversed by a number of profound canyons, with precipitous walls a mile or more in height, and by many others of less depth. It supports some isolated ridges and peaks besides the second region above-named. Upon them occurs some good-sized timber, including trees like *Pinus ponderosa*, Dougl.; *P. edulis*, Eng.; *Juniperus occidentalis*, Hook.; var. *monosperma*, Eng.; *J. pachyphlœa*, Torr.; *Fraxinus pistaciæfolia*, Torr., and *Quercus* of several species; the largest and most important being *Q. undulata*, var. *Gambelii*, Eng., and *Q. oblongifolia*, Torr. Occasionally we see a tree of *Juglans rupestris*, Eng. Among the smaller trees and shrubs, the most conspicuous are *Morus microphylla*, Buckley; *Cercocarpus parvifolius*, Nutt.; *Forestiera Neo-Mexicana*, Gray; *Garrya Fremontii*, Torr.; *Ribes aureum*, Pursh; *Arctostophylos pungens*, H. B. K., and a number of small oaks, notably *Q. grisea*, Liebm., and *Q. hypoleuca*, Eng. These elevated portions, with some river-bottoms, where we often find cotton-woods and sycamores and the gigantic *Alnus oblongifolia*, Torr., constitute about the whole of the forest area of this division. The entire level portion of the plateau is destitute of everything larger than shrubbery, characteristic among which may be mentioned the Yuccas, chiefly *Y. baccata*, Torr., and *Y. angustifolia*, Pursh, Arte-

misias and Ephedras. The alkaline flats are densely covered with a half-shrubby growth—through which travel is nearly impossible—of *Dicorea Brandegei*, Gray; *Oxytænia acerosa*, Nutt., and many species of Atriplex and other Chenopodiaceous and Amarantaceous plants. Upon the sides of some of the canyons occurs an extensive growth of shrubs, but these spots for the most part are exceedingly dry and barren, reflecting back the sunshine from their bare rocks, and maintaining a temperature most trying to the endurance of the collector. Upon these plains there has once been an extensive forest growth, as indicated by the petrifactions that occur. Some of these silicified trunks are of great size. One that I found near Holbrook measured eleven feet from a point just beyond the centre on one side to the periphery upon the other. The remaining portion had separated and fallen down the hillside.

The table-land is a never-ceasing source of surprises to us from the East. During the greater part of the year the surface is dry and desolate, of an ashy gray color; but immediately upon the occurrence of the annual rains it changes with marvellous rapidity. Within three days after the first important showers, a distinct tinge of green is perceptible. In a week the surface is of an almost uniform light green, and in from ten days to two weeks it presents an appearance of great luxuriance. From this time on, until the occurrence of killing frosts, it is a paradise for the collector. Among the earliest plants to mature are those which spring from bulbs, including several beautiful species of Allium and Calochortus, and a Brodiæa or two. Among grasses, Bouteloues and Aristidas are most abundant over the general surface, with Poas, *Agrostis verticillata*, Vill., *Ammophila longifolia*, Benth., and *Setaria caudata*, R. and S., in the low and sandy places. Among these grasses other plants grow, not scattered and intermingled as in the East, but each species occupying a larger or smaller area almost independently. Thus we find patches of golden Pectis, Gutierrezia, Viguiera, Verbesina, Hymenatherum, and Hymenopappus, showy purple Astragali and brilliant many-colored Pentstemons and scarlet Castilleias. In the slightly elevated, broken ground, where the growth of the grasses is disturbed, abounds the Argemone, showy species of Œnothera, Sidas, Malvastrums, and Sphæralceas. One or more species of Eriogonum will be found everywhere. *E. annuum*, Nutt., and *E. Wrightii*, Torr., with the larger form of *E. Abertianum*, Torr., seek the rocky places, while *E. cernuum*, Nutt., and *E. racemosum*, Nutt., prefer the grassy plains, and *E. trichopodum*, Torr., *E. vimineum*, Dougl., and the dwarf form of *E. Abertianum*, Torr., grow almost exclusively in the sand. Certain plants like Rumex, *Bahia*

oppositifolia, T. and G., *Actinella odorata*, Gray, *Dysodia chrysanthemoides*, Lag., *D. Cooperi*, Gray, *Schkuhria Hopkirkii*, and the *Hoffmannseggias*, are almost characteristic of the water-holes, the low places where the rains settle.

This first section extends from the eastern nearly to the western boundary of the territory along its northern border. Its western limit extends diagonally, curving toward the north-east, from the north-western to the south-eastern corner of the territory, dividing it approximately into halves. In its north central point the second region takes its rise, running to the verge of the plateau near Fort Verde, and thence skirting it to the south-eastward and into New Mexico. This belt, known as the San Francisco Forest, consists almost wholly of the *Pinus ponderosa*. It is one of the most beautiful forests in existence, its effect heightened by contrast with the neighboring deserts, from which it must be entered. The same conditions of isolation render it one of the most important of timber resources. The San Francisco Mts., in which this forest takes its rise, have an elevation of about 9,000 ft., and rise some 2,500 or 3,000 ft. above the general level. Their volcanic origin is strikingly apparent. To the eastward they present formidable gulfs and precipices, but to the westward a comparatively easy ascent. At the summit grow only lichens. One or two hundred feet below begins the alpine flora, represented in flower at the time I visited them, July 3d, 1883, by *Cerastiums*, *Sedum rhodantheum*, Gray, *Arenaria scabrella*, Greene, which I collected for the first time; *Polemonium confertum*, Gray; *Luzula spadicea*, DC., var. *parviflora*, and the most beautiful *Primula Parryi*, Gray. This species presented patches of radiant bloom upon the surface of the snow, which had covered its roots to the depth of several inches. *Pedicularis Parryi*, Gray, was abundant a little lower, and at about 8,000 ft. occurs the timber-line. The upper timber consists mostly of firs and spruces, notably the *Pseudotsuga Douglasii*, Cav., with *Pinus aristata*, Eng.; the *Pinus ponderosa* of the forest proper beginning at about 7,000 ft. In the ravines of the upper portion of the forest we collect *Potentilla Thurberi*, Gray, *Mertensia paniculata*, Don., *Pentstemon glaucus*, Graham, var. *stenophyllus*, Gray, *Thalictrum Wrightii*, Gray, *Ligusticum scopulorum*, Gray, *Hieracium Fendleri*, Gray, *Frasera speciosa*, Dougl., *Habenaria Thurberi*, Gray, and a gooseberry, probably *R. lacustre*, Poir. Toward the bottom there is abundance of *Zigadenus elegans*, Pursh, *Erigeron glabellus*, Nutt., and, if I remember correctly, *Aster adscendens*, Lindl. Crossing the slope at the base, we walk nearly waist-deep in fine pasture grasses, chiefly of the long- and short-leaved varieties of *Festuca ovina*, L., to me appearing specifically

distinct. *Poas* and *Sporobolus* are also abundant, and it was here, I think, that I collected *Agropyrum Scribneri*, Vasey. *Oxytropus Lamberti*, Pursh, one of the "Loco-weeds," is much too abundant among these pastures. Two very handsome forms of *Senecio Fendleri*, Gray, grow in dense tufts, a foot in diameter and one to two feet high. In the same manner grow *Euphorbia Pringlei*, Eng., and *E. campestris*, Ch. and Sch. A little swamp-land near the mountain is filled with *Salix rostrata*, Rich. The herbage is closely cropped by the sheep, but we collect *Ranunculus Hookeri*, Regel (*R. cardiophyllus*), *Claytonia perfoliata*, Don., and *Geranium cæspitosum*, James. Near the base of the mountain is a ranche, the door-yard filled with a luxuriant growth of *Aster foliaceus*, var. *Burkei*, Gray—a foot and beautiful aster, growing in large, loose clumps, with ascending stems a foot or eighteen inches high. A mound of scoria in the distance presents a golden surface of *Helenium Hoopesii*, Gray.

This exceedingly meagre outline of the flora of the San Francisco Mts. will apply generally to similar peaks scattered through this forest. On Bill Williams' Mountain, however, situated some fifty miles to the south-west, I collected quite a number of additional species of interest. Among them were *Heuchera rubescens*, Torr.; *Pentstemon Bridgesii*, Gray, *Berberis repens*, Lindl., *Potentilla rivalis*, Nutt., var. *millegrana*, Wats., *Mimulus floribundus*, Dougl., *Taraxacum*, *Aster pauciflorus*, Nutt., *Polygonum Bistorta*, L., *Smilacina sessilifolia*, Nutt., *Disporum trachycarpum*, several Trifoliums and a Cimicifuga in flower only, perhaps our *C. racemosa*, Nutt.

Besides its mountain flora, the forest region has a distinct class of plants characteristic of the dry, stony knolls, 100 to 150 ft. high, which abound there. Of such plants I collected *Erigeron flagellaris*, Gray, several species of *Muhlenbergia*, *Mentzelia lævicaulis*, T. and G. (?), *Sphæralcea Emoryi*, Torr., and a species which has been referred to *Stephanomeria Wrightii*, Gray, but which I am persuaded is distinct from that species. *S. Wrightii* is characterized by great brittleness, with a weak, soft root, while the specimens here referred to possessed stems almost as tough as those of the flax, and long, tough, and hard roots.

The timber, though heavy over the level portion, is not dense, and the sharply stony surface is lightly and thinly carpeted with forest grasses, chiefly *Sporobolus* of several species, with quantities of *Muhlenbergia Wrightii*, Vasey, here and there. Everywhere thickly sprinkled among the grasses are numerous flowering species. Perhaps the most abundant plant throughout this region is *Pentstemon linarioides*, Gray, which displays a great variety of forms. Other of the most characteristic species are *Oxalis decaphylla*, H. B. K., *Astragalus Arizonicus*, Gray,

A. Greenei, Gray, *A. Rusbyi*, Greene, with rarely a specimen of *A. Matthewsii*, Wats.—a species belonging more properly to the open country; *Potentilla subviscosa*, Greene, *Carum Gairdneri*, *Ligusticum montanum*, *Aplopappus croceus*, Gray, *Troximon glaucum*, Nutt., *Senecio Arizonicus*, Greene, *S. Actinella*, Greene, *Actinella Bigelovii*, Gray, *A. scaposa*, Nutt., and *Solidago nana*, Nutt.; early in the season the ground is aflame with the beautiful *Phlox speciosa*, Pursh, var. *Woodhousei*, Gray.

Everywhere through the forest we encounter beautiful open parks, from a few acres to several square miles in area. Here the grasses are taller, often nearly two yards high, and of different species. *Stipa pennata*, L., var. *Neo-Mexicana*, Thurb., and *S. comata*, Trin., are conspicuous. Other plants which constantly occur in such locations are *Senecio Douglassii*, DC., *Aster tanacetifolius*, H. B. K., *A. canescens*, Pursh, *Hymenopappus Mexicanus*, Gray, *Actinella Rusbyi*, Gray, the beautiful *Gilia multiflora*, Nutt., *Eriogonum cernuum*, Nutt., *Astragalus Hosackiæ*, Greene, and many *Eritrichiums* of the *Jamesii*, *glomeratum* and *setosissimum* type. It is usually, or at least very commonly, in these parks that the permanent water-supplies are to be found. The soil underlying the forest consists, for the most part, to a great depth, of loose volcanic rock, upon the surface of which no stream can form a permanent bed. The water-courses, therefore, are far beneath the surface, but reappear occasionally to form living pools of delicious water, often a hundred yards or more in diameter. About these springs are found characteristic species, sedges and rushes, *Iris Missouriensis*, Nutt., *Epilobium paniculatum*, Nutt., *Campanula Scheuchzerii*, Vill, and the like.

During the heavy rains, even this porous soil is not sufficient to absorb the entire fall of water, and it runs off through the hollows, very readily washing out the loose material to form ravines and small canyons of the very roughest class. Up along these canyons creep many of the lowland plants, and down them escape many of those of the highland, producing a richly varied and characteristic flora. *Cnicus* of several species, *Lactuca pulchella*, DC., a peculiar form of *Verbena polystachya*, H. B. K. (?), *Synthyris plantaginea*, Benth., *Hedeoma procumbens*, Greene, a beautiful little species, *Senecio Rusbyi*, Greene, *Pentstemon Palmeri*, Gray, *Prunus demissa*, Walp., *Spiræa millefolium*, Torr., and *S. discolor*, Benth., *Cowania Mexicana*, D. Don, *Ribes cereum*, Dougl., *Fendlera rupicola*, Eng., *Sambucus glaucus*, Nutt., *Lonicera involucrata*, Banks, *Lupinus rivularis*, Dougl., var. *latifolius*, Wats., *Ivesia depauperata*, Gray, *Galium Wrightii*, Gray, and *G. microphyl-*

lum, Gray, *Helianthus Maximiliani*, Schrader, and *Parietaria debilis*, Forst., are among the most characteristic of this diverse flora. Of these, the last six may be mentioned as becoming more common as we descend, and being really plants of the lower districts. Upon the rocky margins of these canyons, in localities especially exposed to the sweeping storms, occurs the peculiar *Spiræa cæspitosa*, Nutt.—a stout shrub, with stem often an inch and a half in diameter, yet its uppermost portions are rarely more than an inch and a half above the rocks on which it lies closely prostrate. In its company are usually some shrubby Eriogonums, notably *E. deflexum*, Torr., *E. microthecum*, Nutt., and *E. flavum*, Nutt.

Continuing our descent of such a canyon until it emerges from the forest, there is an open, but usually grassy plain of greater or less width to traverse, and we stand upon the jagged edge of the plateaus, and gaze into some basin from one to two thousand feet deep, and out across the desert plains which constitute the third region of which I have spoken. At nearly all points upon the edge of this plateau, we find such an abrupt descent. Its passage is rendered still more laborious by the dense tangle of scrub oaks which cover it towards the summit. A consideration of the interesting flora of this lower region forms no part of the present paper.

On the explorations conducted in this forest in 1883, I was accompanied by Mr. Randall Spaulding, to whose exceptional skill in photography we are indebted for the series of views with which my paper has been illustrated, and by Mr. Charles M. Davis and my brother, Mr. Wm. S. Rusby. Through their keen eyesight my list has been enriched with many of its species.

The subject was further discussed by the PRESIDENT, who referred to his own travels in the same region some years before. He described a severe snow-storm on the table-land, with a fall of eight inches in depth, gave reminiscences of bear-hunting in the forests, and alluded to the cliff dwellings in the San Juan valley, and the remarkable and interesting scenery produced by the abundant growth, in many of the valleys, of yuccas, cacti, and century-plants.

January 28, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the Chair.

Eighty persons present.

The first of the regular series of Public Lectures was delivered, by PROF. DARWIN G. EATON, of Brooklyn, upon

VOLCANOES, THEIR DISTRIBUTION, AND PHENOMENA,

illustrated with an extensive series of lantern views, especially of Stromboli and Krakatoa.

The lecture comprised in its scope the following divisions:

1st. A brief account of the milder forms of volcanic action, as exhibited at Stromboli and Kilauea, describing the latter more fully, because of a personal visit to that crater in 1886, when the lecturer had the rare, though disappointing, opportunity of seeing the burning lake of Halemaumau *empty*, and looking upon the yawning chasm or conduit down which the lava disappeared so mysteriously during the night of March 6th of that year. The peculiar action of the Hawaiian volcanoes was then explained, and illustrations given on the screen of the great lava-flow from Mauna Loa in 1881.

2d. A brief description of the explosive and paroxysmal eruptions of other volcanoes, particularly the great eruption of Vesuvius in 1858, at which also the speaker was present, and of the still greater one in 1872.

The lecture closed with an account of the tremendous outburst at Krakatoa in 1883, illustrated with lantern slides, copied from the Report of the Committee appointed by the Royal Society of London. This has recently been published in a large volume, entitled "*Eruption of Krakatoa and Subsequent Phenomena.*"

The leading facts brought out in that report were—that *one cubic mile* of the mountain was blown away, bringing the base down below the level of the sea, while the column of dust rose to the enormous height of seventeen miles, and was carried by the upper currents of the atmosphere entirely around the earth, causing the sunset glows and colored suns and haloes observed in

October and November, 1883. The second of the great explosions, which occurred at 10 A.M., August 27th, was heard at a distance of one to two thousand miles, and in one instance three thousand miles! Ships were sent from several ports in the Indian Ocean to search for vessels supposed to be firing signals of distress.

The seismic waves, some of which were over fifty feet high, swept along the shores of Sumatra and Java, destroying over 36,000 lives.

One of the most interesting manifestations, however, was the great air-wave (not sound-wave) caused by the final outburst. This mighty air-wave spread in every direction, going entirely around the globe seven times, and leaving its record on the automatic barometers at 46 observatories in different parts of the earth; Washington and New York were among these stations where the great impulse was recorded.

A unanimous vote of thanks was tendered to PROF. EATON.

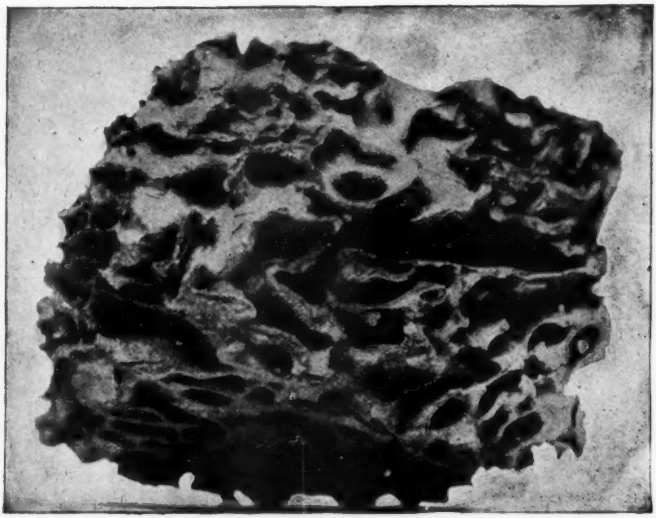


PLATE I.

Portion cut from the interior of nest of *Eutermes*, showing transverse section of queen-cell and of many passages for the workers. Natural size.

February 4, 1889.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-seven persons present.

The Report of the Council was read, recommending:

(1) The payment of certain small bills;
(2) Several minor items;
(3) The election as Resident Member of

MR. ERNEST A. CONGDON,

and presenting a list of nominations for officers for the year 1889, to be voted upon at the Annual Meeting, February 25th.

The several recommendations were agreed to, and the list of nominations approved.

The paper of the evening was then read, as follows:

OBSERVATIONS ON THE TERMITES, OR WHITE ANTS, OF THE ISTHMUS OF PANAMA,

by P. H. DUDLEY.

The paper was largely illustrated, with specimens of all the varieties of ants, with their nests and their galleries, and beams, car-panels, and other wood-work honeycombed and destroyed by them.

When going to the Isthmus for the Panama Railroad, I was requested to make some examinations of the extensive injuries to their buildings, shops, tools, and cars by the Termites, or so-called "White Ants." In the office here in the city, I was shown many specimens of wood-work from the Isthmus so badly eaten by the Termites as to be of no further service.

Nearly all the pieces except those of ash bore evidences also of decay.

The latter fact I fully expected, for the annual rainfall upon the Atlantic side of the Isthmus is about eleven and one-half feet, and on the Pacific side it is only some three feet less. This great humidity, combined with a mean annual temperature of about 78° F., furnishes continuous conditions for the growth of fungi and the consequent rapid decay of wood.

The humidity of the climate serves in a measure to explain why it is so easy for some species of the Termites to eat even sound wood, as in furniture.

What are called seasoned woods there contain from ten to fifteen per cent more moisture than the same kinds would in the United States, and are therefore much softer. White ash, which in this vicinity is a hard wood, and extensively used in furniture, car, and coach construction, on the Isthmus absorbs moisture and is readily eaten by several species of Termites. It seems to be especially relished, and should not form any portion of wood-work to go to the Isthmus.

White pine is but little better, as it so quickly decays and then is readily eaten. Yellow pine is much harder, and in all the samples examined the tissues had first been softened by decay before being attacked by the Termites. It only requires from one to five years, however, according to the conditions of use, before the yellow pine is attacked by fungi and then by the Termites, especially *Termes testaceus* Linn., which eat out the interior portions of large timbers, such as posts and sills of buildings. It has been often suggested to treat the wood so as to check decay, and thus to prevent the work of the Termites. This course has been extensively tried, but the majority of cases have been failures, owing to the difficulty of treating the interior portions of large timbers; and measures which would protect the timber from decay in temperate climates fail in the tropics.

Upon the Isthmus, ten species of Termites have been found, representing three genera, according to Dr. H. A. Hagen,—viz., *Calotermes*, *Termes*, and *Eutermes*. The first genus is represented by only one species, *Calotermes marginipennis* Latr., and so far has only been found in first-class passenger coaches, which were in daily service. In two of the coaches, the attacks were confined to the white ash door-posts, and in the third coach the rails of twelve seats were destroyed. The wood was not attacked from the exterior, nor were any covered galleries found. Entrance to the interior portion was gained through a crevice at the joints. The wood is then eaten out in pockets or chambers, working principally lengthwise of the grain. It would seem, on looking at the chambers, as though a heading was driven by one or two workers, and enlarged by others following in close proximity. If a heading from an opposite direction was likely to meet, a thin partition wall would be left, especially when near the surface of the wood. The chambers were larger in the central portions of the sticks. The exterior portion, or the surface, was not eaten through, and the only indication afforded was the dust or *fæces* falling from the joints of the

seats or door-posts. This species has not shown any evidence of using glutinous secretions in repacking the excavated chambers or tunnels; but a few of the chambers were repacked with loose pellets—*fæces*. This species is very destructive to ash wood, and can readily bore hard oak. Eating out the interior of the wood in chambers, they cannot be easily dislodged.

In the classification of the Termes and the Eutermes, there is great confusion. The latter have been separated from the former on account of a supposed constant difference in the venation of the wings, which does not seem to hold good with the several species from the Isthmus at least. The present classification puts into the same genus—*Eutermes*—species having soldiers provided with long, curved mandibles, and species having soldiers with their heads terminating in a long "nose" or beak from which they eject a minute glutinous pellet or shot when attacked. Upon the Isthmus, the habits and nests of species having soldiers of the first kind are entirely distinct from those of the species having soldiers with long noses (nasuti). To avoid confusion, in this paper, species in which the soldiers have long, curved mandibles will be mentioned as *Termes*, and those having nasuti soldiers as *Eutermes*.

Five distinct species of *Termes* have been thus far collected upon the Isthmus: *i. e.*, the soldiers and workers of as many species have been found, but the queen of only one of these has been obtained. One species builds conical nests of mud or earth, after the manner of some of the African Termites, the largest found being three and one-half feet in diameter, and the same in height. This nest is near Corozal Station of the Panama Railroad.

The nest of the species of *Termes* in which the queen was found was upon a decaying stump on Kenney's Bluff, across the bay from Colon. The workers are comparatively small, less than three-sixteenths of an inch long. The umber-colored nest had very small passages,—some of them formed by eating out the wood, while others were constructed. The queen's cell was nicely formed, the interior being quite smooth. The other species of *Termes* have been collected in the pieces of wood or trees upon which they were feeding. The only portions of nests found are those obtained inside the larger posts of buildings which they were attacking. These were perhaps only auxiliary nests, as queens or their cells were not found. The *Termes* make covered galleries leading from their nests, but not so extensively or conspicuously as the *Eutermes*, at least not upon the Isthmus.

Most of the species of *Termes*, when eating the wood of a building, make galleries between boards or through the interior of the wood, never breaking through to the exterior.

The systems of covered galleries of the *Eutermes* are very extensive, being conspicuous upon many of the tallest trees in the forest. A main gallery is constructed from the base of the tree, running up the trunk to the branches, and then auxiliary galleries on the under side of all the boughs, large and small (Fig. 1).

The *Eutermes* live in large communities, and build upon small trees a nearly globular nest from six to twenty inches in diameter. In larger trees, the shape varies. In the central portion of the nest is the queen's cell, in which from one to ten

FIG. 1.—Nests of *Eutermes*. In the centre a palm-tree, with main or parent nest, and two galleries leading to the ground: on either side, supplementary nests. The main nest contains several queens; the others have none, but abound in eggs and young.

mature queens have been found. Twenty queens, not fully grown, were found in one instance in a single cell.

From the nests the covered galleries of three-eighths to three quarters of an inch wide, and nearly semi-circular, extend often one hundred and fifty to two hundred feet to some source of food-supplies,—as buildings, cars, etc. (Fig. 2).

The members of their communities consist of workers, soldiers with beaks (nasuti),—the former many times the most numerous,—and a queen or queens. In the spring there are large quantities of males and females, which have eyes and wings,

and these swarm about the end of May or beginning of June. The soldiers and workers are blind and wingless, and do not swarm.

My experience with the decay of woods enabled me at once to recommend more durable woods for use on the Isthmus, which were at once adopted. In order to see whether those woods were proof against the ravages of the Termites, I arranged with Mr. J. Beaumont, Superintendent of Motive Power of the Panama Railroad, to make continued observations upon the habits of the different species, and ascertain how far the woods recommended as less liable to decay were also proof against the ants. The interesting observations of Mr. Beaumont, contained in his

FIG. 2.—Nest of *Eutermes* in the fork of a small tree, six feet above the ground: it contains four queens. At the root is a supplementary nest, with soldiers, workers, eggs, and winged ants, but no queen.

numerous letters, have been compiled by Mrs. Dudley into the following paper:

COLON (ASPINWALL), U. S. COLOMBIA,
March 4th, 1888.

MY DEAR MR. DUDLEY:—In answer to your questions about the habits and work of the Termites, I reply that one cannot fail to notice here, in the month of May or June, the swarming of the winged white ants,—after and during the *first* showers of the wet season. They cover and get into everything, so that one has to sweep them off from the balconies. Few

seem to know that they are white ants, but I have watched them issue from their nests, located in rotting or decayed 12x12 timber in roofs of buildings, and also on fences. At this time everything at the nest seems to be in a high state of excitement. As soon as the winged ants alight, they shed their wings, and then crawl after each other in long lines, apparently trying to pair. The winged ant is about three times the length of the workers, and I never see it at any other time of the year.

In regard to the galleries about which you inquire, I have not noticed any on the ground, but always on a post, fence, or foundation-pier of buildings. The damage this little insect is causing to the buildings of the Panama Canal Co. and to woodwork on the machinery, with the work of the fungi, must be simply immense. There is hardly a Canal building, elevated above the ground on stone or brick piers, but what has these galleries of white ants running up and around it, dooming the building or its furniture to destruction. New ash or oak furniture in our Commissary building is frequently destroyed. Kerosene will kill some, but does not prevent others from attacking the same piece of wood or furniture after the oil has evaporated. Fernoline might answer, as it retains its odor longer. I find by experience that it is best to get to the nest or colony, destroy it with kerosene, and take it down and burn it. I have one man detailed to go around every Saturday, break all the galleries, and tear down the nests and burn them.

At your request that I would break open their galleries and watch the ants repair them, I went to a place where I had noticed them, on a lignum. vitæ fence-post in my garden. A few days ago, I opened several tracks or galleries, and found the samples in bottle No. 2 (soldiers, nasuti) to be most numerous just then, and very few like specimens No. 1 (workers). This was the first time that I broke open the galleries for observation.

This morning the galleries were being repaired in some places only, while others were untouched. On disturbing other portions of the tracks, I failed to notice any workers, but swarms of soldiers or black-heads.

With the naked eye I could not distinguish the motions of the repairers, so I took my eye-glasses folded together, and made a magnifier about equal to a watch-maker's glass, and then I inwardly exclaimed, Eureka! Eureka! There were the black-heads—nasuti soldiers—all clustering around the break, heads or beaks pointing out, and when my breath disturbed them, giving a series of bodily jerks as though stabbing an imaginary enemy. At other times they were continually swaying their heads back and forth (Fig. 3). I failed at first to see any repairs—but stop! what was that little fellow doing? There is another:

he just puts up his head on the edge of the break, with a grain of something dark between his mandibles, and presses it firmly into position by a side movement of the head three or four times, then turns and disappears. I notice that as he turns, he has a peculiar way of showing the other extremity of his body. They all do exactly the same; the black-heads (nasuti soldiers), always allowing them room to work, swaying their beaks back and forth.

I clean my glasses and hold my breath, looking again, and discover the whole process.

Up comes a little worker with a grain of white, sticks it on the edge, and, pressing it into position with its mandibles, backs down a trifle; then up comes the end of its abdomen, and ejects upon the little grain, just rubbed in position, a drop of a semi-liquid substance of a whitish color. This whole operation only occupies a few seconds.

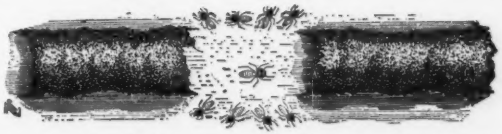


FIG. 3.—Broken gallery of *Eutermes*, showing soldiers (nasuti) guarding the break, while workers are engaged in repairing it. Natural size.

Then he trots below. Up comes another, with a grain of *brown* (soil) and pats it down, but it dips a trifle; gets hold of it again, another pat—successful. Then up comes the abdomen with the glue; and this is the process on both sides of the break.

I found two breaks in the galleries repaired, nothing being done at the others, the community apparently all quiet. I note that the sun is shining on the break; perhaps that is the reason.

I made some more extensive breaks, causing a general commotion; very few workers visible, but I captured some. This kind seems to get out of the way very fast, while the soldiers spread all around in a very excited manner; but the sun, being hot, soon drove them into the shade. . . .

In a conversation with the American Consul here, lately from Barranquila and Carthagena, U. S. Colombia, he told me that the only wood that is proof against these ants in the houses there is Spanish cedar. They do not like the flavor or smell of it, and so it is used for floors and ceiling. He also told me of the immense destruction to buildings in that place by these ants, and added that they can be heard at work in the night when it is quiet, grinding away at the wood, and assured me that he had heard them himself.

Now a few words as to their work on moist wood. About a month ago, during dry weather, one of my workmen had some ash panels for inside finish of coaches, and laid them on his bench piled up, six or more in thickness, without anything between. The ants found them, and in a few days ruined them. This was apparently dry lumber. They attacked some white-wood along the tongue and groove, at about the same time. The carpenters tell me that the ants will not touch a board lying alone, but if several are placed over each other, they will work between them. I notice that I find fewer tracks of ants or nests in the dry season than in the wet. I have just found a portion of another "last year's nest" in an 8 x 8 stick of yellow pine, which I think may interest you, as it shows the way they construct their houses or nests. I have just been looking at a vial of ants that I have bottled for you. They are from the same place I got the others, which you class as another variety, and I agree with you from what I have seen of them. Their galleries are much smaller, about one-sixteenth inch diameter inside, and one-eighth inch diameter outside, and apparently made of soil. They are very shy and difficult to capture; and as soon as the gallery is disturbed, they disappear quickly. I have not found any working on wood yet; in fact very few wood-ants are at work just now. I have only two nests under observation;—perhaps dry weather is unfavorable. . . .

I broke two or three of their galleries, thinking to return after a while and see them at work repairing again. But when I returned it was all done. So about noon I went again, took out my glass, and broke two galleries; one was running up the fence-post, so that the sun, being directly overhead, shone into the gallery to some depth. The other, some two inches away, did not admit the rays of the sun. I noticed they seemed to be most anxious to work on the one that admitted the sun's direct rays. In about five minutes I began to see the little fellows with the cement come along and examine the break, but they brought nothing; I observed, however, that they turned and placed a little cement on the edge of the break. Six or eight did this: then one little fellow came with the first "brick," patted it into position, gave it the regulation number of rubs, then turned around and placed a little cement there for the next brick. Is this not wonderful? Who but the All-wise Creator told these little creatures of His handiwork that the dry grains would not stick on the dry walls of their galleries without first being moistened?

The other fellows with the black, shiny beaks (nasuti soldiers) seemed to do the running around. I have not seen them use their beaks, but I do not think that they open. My glass is not

powerful enough. All work together in harmony; and the rapidity with which they were laying bricks when I left them led me to judge that they would finish the break of three-eighths of an inch in about twenty minutes.

You can certainly rely upon their method of repairing broken galleries as I have described it, for I have watched them minutely and carefully many times. I have not yet seen any of their larvæ or eggs; but the time will soon come for the winged ones to fly, and then I must get some for you. . . . I have just made another observation of their repairing a broken gallery, with exactly the same result, and am curious to know where they get their material so quickly. It hardly seems possible for them to go from the top of a four-foot fence-post to the ground and back in five minutes. I have known them to repair a broken gallery a dozen times a day.

April 4th, 1888. To-day a box-car was sent to the shop for repairs; it has been lying on a side-track up the road, and was eaten by these ants from brake-beam to roof,—good for nothing but fire-wood,—it is a sight to behold. I have just had quite a "picnic" with the Termites in it, and my hands have a pungent smell yet, in spite of frequent washing with soap. When the men began to break up the car, they found under the roof in one corner a large nest, about the size of a half-bushel basket, globular in shape, with an outside covering, samples of which I send to you. This nest was held in place, or supported, on the under side at intervals, and when touched with the fingers would crack, but not break away. I at once took this large nest in my hands, and broke it in two on the flange of a car-wheel, when, to my delight, I found the largest white ants I have sent you, with embryo wings. These seemed to be congregated in the centre of the nest. I recognized them as the winged ants that issue forth in such quantities at the commencement of the rainy season. They are then longer, and smaller in diameter, and of a darker color than the samples sent. I hastily collected a number in the palm of my hand, and bottled them. The other samples sent were taken at random from the fence-post nest; I think there are three kinds. I took a portion of the latter nest on my desk, and collected in one bottle all the white ants I could capture. They are of a retiring nature, and hid in the cells of the nest, from which it was difficult to dislodge them. There seem to be two kinds; the smaller are the ones that carried the cement and built up the galleries. The others are longer, and with amber-colored heads, and are seen only when I break largely into the nest. The other kind was that with the beak and shining black heads. From your description, I think the white ones are females or queens, and rarely leave their cells.

April 8th, 1888. This morning I have been studying the Termites (*Eutermes*), with the following results:—I watched their actions for forty-five minutes without intermission or abatement of interest, and, using a more powerful lens, I confirmed many of my previous observations. I wished to-day to note whether the *Eutermes* would attack ants or other insects, or be much disturbed by their presence. So I made a break of about three-eighths of an inch in a gallery on a fence-post. None but those with the shiny black heads with beaks (nasuti soldiers) put in an appearance for at least fifteen minutes. So I caught a common black ant, killed it, and pinned it in the centre of the broken gallery. The nasuti soldiers approached it very cautiously with their feelers and seemed afraid of it. In a few moments a worker came with the prepared glue, barely touched it, then turned around and dropped a speck of glue, then another, and so on until six had done so; then some grains of sand were brought and placed on the ant, which was now securely glued down. I withdrew the pin, but the ant was fast and immovable, and they seemed to leave this work. In the meantime, I had broken other galleries, to which I was giving attention. One, a very small break, I noticed them closing up without using any grains of sand, or but a very few. I watched this closely: some of the ejections were darker than others; some were very profuse, while others were scarcely discernible, but all of about the same consistence. The color at first was a light yellow, but in a moment or two of exposure to the sun it became very dark or brownish-black. The workers, when making this deposit, made a sweep with the abdomen, spreading it along the edge of the gallery. While the aperture of the gallery was being closed, the black-heads—nasuti soldiers—kept their heads and antennæ over the edge, until finally there was only room for the antennæ of one in the opening; these were then pulled in,—another drop, and the world to them was shut out. While watching this operation I found that my little prisoner—the black ant—had been excluded from the gallery by building a curved portion around him, joining the ends of the former gallery,—just wonderful! (Fig. 4).

May 3d. Yesterday I met our friends the Termites again, and found them more interesting than ever. I disturbed a block of wood, of which they had entire possession, and turned it up edgewise. In doing this, their runs or galleries were broken, and several workers were wounded and crushed. These were removed at once by other workers, and taken carefully into the galleries. The order to do this seemed to me to be given by the soldiers, but in no case did they assist in their removal. I watched with interest their evident intention of connecting the

broken gallery, which was now on the top edge of the block, with the one at the bottom, a space of six inches. The soldiers seemed again to be directing the work, and in about fifteen minutes it was planned and commenced. The soldiers took position in a double line, while the workers ran up and down between them. This evidently meant the direction of the new

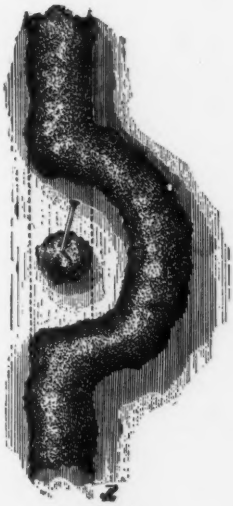


FIG. 4.

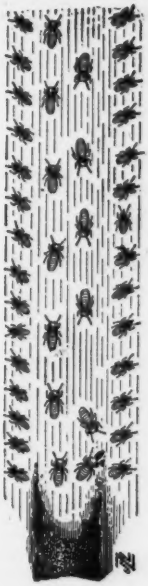


FIG. 5.

FIG. 4.—Gallery of *Eutermes*, broken and repaired. Original position shown by dotted lines, while the new portion is built around the obstruction. The latter consists of an ant, pinned in the middle of the break for experiment, and forthwith enclosed in cement by the workers. Natural size.

FIG. 5.—Portion of a double line of *Eutermes* soldiers (nasuti) enclosing and guarding workers while constructing a gallery. Natural size.

gallery; and the former did nothing but sway their feelers back and forth. I left them with the impression that the soldiers were directing the work (Fig. 5).

There has just been brought to me a portion of a nest of another colony of Termites: the result I send as a separate story, calling it

THE "BATTLE OF THE EUTERMES."

May 3d, 1888. I have never seen or heard of such a marvellous exhibition of intelligence and warlike skill as I witnessed to-day, after putting together workers and soldiers of two different nests of *Eutermes*. Their skill and dexterity in despatching an enemy are astonishing.

There was a slight difference in color between the occupants of the two nests, which was very favorable for accurate observations. And the better to designate the combatants, I shall call those of one nest "yellows," and those of the other "whites."

The yellows had the advantage of being at home, which was a block of wood six by six inches and three feet long, and literally honeycombed with tunnels or headings containing a numerous community. At the moment of attack the yellows were busily repairing a break in one of their galleries, "trowel in one hand and sword in the other," as it were, when I approached with the nest of the whites and dropped a single worker from the nest to the yellows' block, expecting to see it mingle with the latter unobserved; but had I dropped a miniature dynamite bomb, I could not have caused more confusion. A soldier (nasutus) of the yellows first discovered the intruder—by scent, I think—and rushed to the galleries where the workers were busy, and gave the alarm; instantly a worker of the yellows rushed at the intruder with open mandibles, grappled with it, and soon laid it on its back motionless and apparently dead. The yellows were now mustering out in great force, so I jarred my nest of the whites over the block, causing hundreds to drop on the "field of battle"; instantly the workers from the different nests rushed at one another with mandibles open. The battle was raging fiercely, in a rough-and-tumble manner. I dropped my nest, and took out my lens for observation. In a few moments the bodies of the workers of the whites were strewn all over the ground. It was very exciting to see them grapple together, and then roll over and over, the workers of the yellows being generally victorious. I now jarred from the nest of the whites another large reinforcement, mostly workers, there being but few nasuti soldiers in the nest. The yellows had many soldiers, which were rushing around, directing and urging the workers of the yellows to battle.

I was astonished how quickly they killed each other, but after a little closer observation I discovered the trick; the workers of the whites which I thought were dead were still alive, but *hors de combat*,—dismembered, in other words,—their feet or legs, and antennæ bitten off.

In all probability this was their first pitched battle, yet they fought like skilled warriors.

The yellows were evidently the most expert. I picked up a worker of the yellows and placed him on the nest of the whites, and he dismembered half a dozen of the latter before he was made to bite the dust. I could distinctly see the mangled legs of the slaughtered covering the battle-ground like white dust. I now left them, wrapped in astonishment at the wonderful works of the Creator. After dark, I returned with my lantern, and saw the workers of the yellows running among the slaughtered, nipping off a leg closer to the body of any which still struggled. There was fully a pint of the slaughtered bodies. It was astonishing how quickly they were despatched.

May 4th, 1888. Yesterday afternoon we had our first rain of the season, with thunder and lightning; and, as I have before remarked, the winged ants came forth, and I will send you some samples. . . .

May 6th. To-day I collected specimens of two more varieties of white ants, and have numbered them 3 and 4. The nest of No. 3 (identified by Dr. Hagen as *Termes testaceus* Linn.) I discovered in the window-casing of my office, which they have nearly destroyed, as also the frame. They came through the paint in one spot, and were then discovered. I procured specimens of soldiers and workers. They are very different in form and color from what I term the common wood-ant. Their bodies are longer, and the soldiers, in place of the beak, have powerful mandibles of a dark brown color, with yellow heads, and white bodies which turn yellow in alcohol. The workers are milk-white, and hold their color in alcohol. Both have a fat, white, waxy look under the lens. The soldiers, when disturbed by being touched roughly, strike with the mandibles, and then vomit forth a drop of gelatinous, milky fluid. When slightly disturbed, they make the same spasmodic vibration that I have noticed in the nasuti soldiers of *Eutermes;* but as their bodies are somewhat longer, the movement is more conspicuous. I placed a number on a sheet of writing-paper lying loosely on my desk, and was astonished at the rattling noise they made. Balancing themselves on their feet, they would tilt their heads up and down, and strike their long mandibles on the paper so rapidly as to sound like a stream of fine gravel dropping on the paper, and could be heard for a distance of ten feet. I thought this movement a method of communication among them, as they made frequent use of it. Of course, the paper did not lie solidly on the desk, and so acted as a sort of sounding-board.

When attacked by other ants, they made wicked use of their powerful mandibles, and if the enemy was too much for them they would vomit a drop of the milky fluid, which seemed to suffocate the enemy. I noted that when dropped into the alco-

hol they would discharge the same milky juice, which may be seen adhering to the mandibles of some of the specimens.

Species No. 4 I found on a post near our coal-bin, and I think they are the same as those sent with my first samples to you. They have the same appearance as No. 3 (*Termes testaceus* Linn.), but are much smaller, and without the milky secretion in the soldiers.

I placed a number of *Termes testaceus* L. (No. 3) in a glass jar, —both soldiers and workers,—adjusted my lens, and then dropped in several of No. 4, and watched their manœuvres for some time. They rushed to battle at once. No. 3 made use of both mandibles and milky secretions. A No. 4 worker caught hold of a No. 3 soldier by the abdomen and pierced it, and out burst quite a flow of milky fluid, apparently nearly suffocating the assailant; while No. 3, very much reduced in size by loss of its secretions, turned in a rage on No. 4 and nearly clipped it in twain.

I punctured the abdomens of several soldiers of No. 3 with a pin, and the same discharge of milky secretion followed as they seem to vomit when disturbed. I procured soldiers, workers, and winged ants from the same post. I consider this important, as the different species swarm together, and it would be difficult to distinguish them otherwise.

I took some of No. 3 (*T. testaceus* L.) to No. 1 (*Eutermes* worker)—what I call the common wood-ant—and though they had mustered hastily and turned out in force to repel the invading army of their own kind a few days before, they avoided the *milk-men*, and attempted to push them away from their broken galleries in one or two instances. They seemed disgusted with the milky secretions, and only desirous to be left alone.

May 7th, 1888. To-day I tore down a portion of the casing of my office window to solve the mystery of No. 3 (*T. testaceus* L.). I found the wood-work a mere shell, and the space that was once solid occupied by a mass of pasty material, evidently composed of what seemed to be wood chafings mixed with some moist glutinous substance formed by the ants, and constructed into runs and galleries. What surprised me most was its *moist nature* in such dry weather. I am now satisfied that this is the same kind of ant that formed the nest in the tie-beam that I sent you. The material, as a nest, is entirely different in character from No. 1 (*Eutermes*). I observe that No. 3 (*T. testaceus* L.) does not form runs or galleries on the *surface* and away from its work of destruction, but confines itself *within* the beam or post where it is working. No. 1 (*Eutermes*) will make nests up in a tree, or on a fence-rail or post, or under the roof of a building, away from its work of destruction, and then run its tracks or galleries there-

from in almost every direction, in search of choice wood or material to work upon and devour.

When I took down the side of my window-casing, it was a wonderful sight to behold,—thousands of milk-white ants, soldiers and workers only. I secured a number of workers, as they soon disappear. The soldiers evidently thought they would secure me, and bit viciously at my hand; their mandibles, once fixed, stayed until pulled off by force, separating their bodies before letting go their hold. I secured several fine samples of their galleries. The whole window-frame is destroyed, and will be replaced by a new one,—when more treasure may be found.

What interested me most were the places where they broke through the surface of the paint,—*the holes would be carefully puttied.* On breaking them open, the ants could be seen filling them again, the soldiers always standing guard around the edge, as with *Eutermes.* I caught sight of the workers bringing the grains of material and placing them in position carefully, but not turning around and cementing them together as the *Eutermes* do. These grains were of a reddish color, soft and pasty. They were always of the same nature, as though prepared for the occasion. Under the lens they looked like little pellets of some adhesive substance. I will send you some to be analyzed.

I feel gratified by having my observations made known to such a good authority as Dr. Hagen, and still more to learn from him that they were of some value. I wish there was some authority here for me to consult on the subject, but there is none save my own observations. I trust these are made as carefully as possible, and that they will be criticised in the same manner.

The remarks in your letter made by Dr. Hagen, on certain ants vomiting masticated wood, throw a little light on some of my notes, and happily may verify his statement on this point. I do not think my observations will allow me to agree entirely with him that two or more species of Termites occupy the same nest.

Mr. Clark, chief engineer of the steamer *City of Para*, was with me this morning, and I took him out to see my ants (*Eutermes*) repair their galleries. I broke one on a lignum-vitæ cross-tie; and in five minutes, to my delight, he saw them, with the naked eye, turn around after placing the grain, and with my lens saw the secretion deposited. He is the first one to whom I have shown this. The little workers repaired about one-eighth of the break while under observation.

May 13th, 1888. When going to my house this morning, I found tracks of *Eutermes* on a box of plants belonging to my wife;

so I can make observations with more ease and comfort. I also saw a boy wheeling away in a barrow the *outside* of a new washstand, the *inside* destroyed by *Eutermes*. This could be seen at a glance from my window, a couple of rods away. It is a common thing for them to attack washstands and bureaus in houses here, especially if made of ash. This reminds me of your question, "Have you many cars destroyed by ants?" I have only seen the one mentioned, and that had lain on a side-track for several months. As a rule, our cars do not stand still long enough for their work to commence. We had a Cook locomotive belonging to the Canal Co. sent to our shop some time ago, that had been standing out of use in one of their sheds for several months, with the wood-work attacked by *Eutermes*.

I have just had the pleasure of showing my wife the *Eutermes* repairing their galleries on her plant-box. With the lens she saw them set the grains, then turn around to spread the mortar. I also found their track or tunnel from one corner of the box under the soil for an inch or two from the side of the box, and some little depth below. I think their tracks are constructed with fine grains of sand or particles of soil, in combination with their secretions; but their nests are made of finer and more durable material, as the fine cuttings of wood, perhaps partly digested, and their secretions. Their nests are delicately constructed and the surfaces smoothly finished. . . .

In order to make more exact observations of my pets, I have established two "Termitariums" (name original), portable, in which I have very conveniently watched them hour after hour, in mute admiration of their skilful work.

I procured two telegraph-jars from the battery-room, and with these formed my Termitariums. The first nest of *Termes testaceus* L. was put in the jar a week ago and is working well; this was taken from my office window when the new frame was put in. We had quite a "picnic" at that time; I never saw so many ants before. The winged ones swarmed in such numbers as to fill my office; the floor, desk, and outside were alive with them. The swallows or martins soon found them and had a feast. The carpenters were covered with them and badly bitten by the soldiers. I picked up winged ones by the handful, and also workers and soldiers, for yourself and Dr. Hagen, and am thus certain that they all came from the same nest. I could not find the queen, though I hunted for her long and carefully.

The second Termitarium was formed on May 20th, 1888, from the *Eutermes* nest under my observation for a long time. These are the most interesting, active, and intelligent of any of the three varieties of which I have sent you samples. I formed the Termitarium in this manner: First a half-inch layer of damp

soil, then a circular piece of white pine board about two inches less in diameter than the glass jar, which is six inches wide by nine deep. I placed the board on the soil for them to feed upon, and then filled up between the circular board and the sides of the jar with more soil, for them to use in building galleries. Then, without disturbing or breaking the roof of a nest, I carefully selected a piece of irregular form and trimmed it to go into the jar, leaving it about 6x4x5 inches, and placed it in the jar so that two sides touched the glass. It rested on the board, leaving a portion exposed for observation. The nest, I judge, contained several thousand nasuti and workers, the latter predominating. In a few moments they accepted the situation, and began throwing up earth-works, repairing the broken nest, forming tunnels under the soil, stopping up holes, and cementing the sides of the nest to the glass jar,—all working harmoniously and after a well-defined plan. The gelatinous secretions were used sparingly at first, as the soil was moist and they were in a great hurry. It did not take them long to find that they could not crawl up the slippery sides of the glass, and they wasted no time on the attempt.

It was interesting to watch them tunnel the soil next to the sides and bottom of the jar, sometimes ramming the soil with their heads, and again removing large grains to the surface, rarely using any secretions under ground. They put me in mind of a large crowd of men at a fire, only in this case they were all busy and none standing idle. Even the soldiers scurried around, apparently directing the workers to different places; their function seems to be as guards or sentinels to alarm the workers, and they do it well. They do not appear to fight or work.

Having partially repaired their nest, and made a general survey of their work, they began to divide into parties, each having apparently a certain portion to accomplish. The workers were busy eating the wood, gnawing, tugging, and pulling in good earnest.

On the second day, a scouting party of soldiers (nasuti) on the top of the nest looked up anxiously to the top of the jar, and waved their antennæ upwards, standing on tip-toe. They kept this position a long time, while others were running up and down. I soon divined their intention to be to find a way of escape from the jar. Meanwhile, thousands of workers were eating the wood and working at nest-building as though they intended to stay there; not one appeared idle, sick, or even tired.

On the evening of the second day, I saw a party of workers starting a track of cement up the side of the jar, using no soil,

only their secretions, which showed through the glass like a brownish frosting. It looked beautiful, as well as wonderful, and their method of doing it was very ingenious.

The next day, they commenced two tracks up the sides of the jar, by backing-up as high as they could reach with the extremity of their abdomens, and then making a deposit of the glutinous secretion. Each one would go up head-first, as high as it could climb on the secretion, and apparently mark the place of

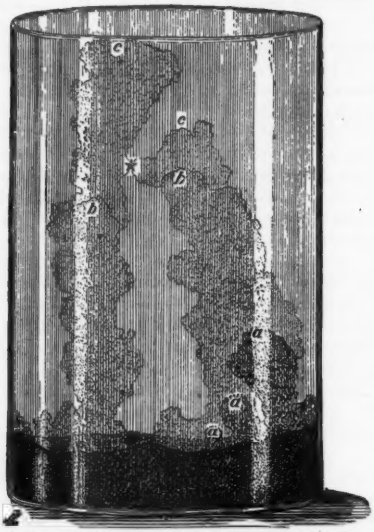


FIG. 6.—Device of *Eutermes* to escape from a glass jar, in Mr. Beaumont's Termitarium, by coating the inner surface of the glass with cement, supplied from the eductors of the workers, so as to afford a foothold. The lower part of the jar is occupied with earth, and the cement-tracks were carried thence to the top in three days' successive extensions, reaching to *a*, *a*, *a*, on the first day; to *b*, *b*, on the second; and to *c*, *c*, on the third. The two tracks unite at the star; and escape was effected at the top. One-third natural size.

deposit, then turn around and back-up again. I think this was wonderful. These little fellows had never been in such a situation before, yet, nothing daunted, they were equal to the occasion. While admiring their perseverance, I regretted seeing their attempt to escape from me, as I wished them to settle down and be contented. While this work was being done upon the sides of the jar, the majority were busy eating the pine wood and nest-building,—the work seeming to be divided up into sections (Fig. 6).

On the morning of the third day, they were within an inch and a half of the top of the jar; so I placed a writing-pad on the top, for fear that they would be out before I returned from breakfast. But this was not sufficient; for my boy came running to my office, saying that my prisoners "were escaping by the hundred." I told him to place the jar in water until my return, and on reaching them, I found a regular procession of several thousand. They had plastered the under side of the pad, to gain a foothold until they reached its edge, and then they were free. . . . From all this I derive the following conclusions: 1st. The soldiers are chiefly watchmen and directors for the workers. 2d. The workers make continuous use of their profuse secretions in the construction of their nests and galleries, and in the burial of their dead (enemies), or in escaping from confinement.

May 23d, 1888. Last night I took a worker *Eutermes* from a nest in my garden, and dropped it into the midst of workers in my Termitarium. Instantly it was pounced upon by all that could get to it, legs and antennæ clipped off, and in less than five minutes the workers were backing up to it and depositing their secretions upon it, while others were bringing grains of soil and covering it. In about fifteen minutes they had literally buried it alive in a hermetically sealed coffin. I procured others, and they were treated in the same way. I was now curious to know if they would recognize members from their own nest after five days' absence, and resolved to make the test. It was a success. I had noticed a piece of a wooden barrel-hoop lying by a part of the old nest, from which I had taken a portion. It was hollowed out in the centre and contained hundreds of ants. I carried it carefully and stuck it into my jar so tenderly as not to disturb or crush one. Wonderful to relate, without any visible demonstration, they intermingled as if they had always been together. Those which had been in the jar for five days seemed glad and excited at the acquisition of the old barrel-hoop, and began to incorporate it with the nest; new galleries were commenced over it, and they all seemed happy. They evidently recognize members of their own nest, in distinction from their own kind from another nest. They must detect a stranger from another nest by the sense of smell. They also notice fragments from a strange nest as quickly as they do the ants. A strong light from either lamp or sun does not seem to be noticed by them in the least. I laid a piece of lead-pencil on the soil in my Termitarium. They at once formed a procession of inspection from either end, and in passing each other they would drop from the smooth surface, about the rate of one each second. In a few moments, the glue was called for, and they

stood upon their heads on both sides, reaching up with their abdomens, dotting the sides, and others on the surface. In a short time, there were none falling, the pencil was specked all over, with occasionally a grain of soil.

I have just closed up a small box to send to you. It contains samples of nest of *T. testaceus* L., from my office window. The old nail I found imbedded in a solid mass of the nest about three inches thick. This seems to prove that as these ants devour the wood, they fill up the cavity thus made with their nest; hence the nail was incorporated. . . . I am now trying my pets, *Eutermes*, with different kinds of wood, to see which they relish best. I have found them at work among a pile of lignum-vitæ ties.

June 2d, 1888. The ants are to me an inexhaustible subject. . . . It is now about three weeks since they took up their abode on my study table, and they are apparently happy and contented, and they seem fatter than when they arrived.

I have been lately closely watching the soldier *Eutermes* (the nasuti), with a view of giving you a better definition of the peculiar functions of their horn-like beak or proboscis,—but without much success, and shall have to continue to call them a soldier-guard. They seem more inquisitive than their fellow-workers, and at the same time more cautious. If the point of a pencil is placed among the group gently, they will touch it with their antennæ, and then retreat a little, or hurry off to warn the rest. A worker will come along, feel carefully at the pencil, and then crawl up it, at once, in a sociable way. I can always pick up a worker in this manner, to examine with my glass; but a soldier is too wary, and requires finesse to capture him,—such as rubbing the point of the pencil on the nest, to give it a similar odor,—and this must be its own, for each nest has its own peculiar odor *to them*.

The vibratory movement that I first noticed in this species seems to be common to the three kinds of wood-ants that have been here noted; it seems to be a part of ant-language, for the soldiers make the most frequent use of it. Ants are wonderfully inventive in adapting themselves to a change of circumstances and situation; for instance, out of doors they are *never* seen at work, but are always under cover, and can only be observed,—and then, of course, not at work,—when the nest or gallery is broken. But here, in my glass Termitarium, I can feed them with different kinds of wood, on which they fall to work with great avidity, exposed to view, and in strong light, with no attempt at concealment, and this on the first day after installment. Why this sudden change in their method of work? How did they learn that they were not exposed to the weather,

or to danger from other ants, in their new location? They have worked in this manner for over two weeks, and every two or three days I would take out samples of their wonderful wood-carving, and insert fresh pieces for them, and in a few moments they would be patiently feeding on the new samples, without demur at the frequent change,—except yesterday, when I gave them a piece of ash, their favorite wood. To my astonishment, this morning it was incased and entirely hidden from view. They evidently intended to have this choice morsel all to themselves this time. The frequent changing must probably annoy them a trifle, and they intend to prevent it. Pages could be written upon their winning ways and marvellous skill. To-night they were feeding on a strip of ash, one inch by three, as many on it as could stand closely together, all workers except a few soldiers on the outskirts. . . . I watched them closely, and kept my eye on one until it cut out a minute sliver, and then went off with it to the nest, to masticate or chew the cud. Others seemed to get their mouths full, and then went away, their places being taken, so that the table was always full. In cutting, they seem to fix one mandible in a cell of the ash, and then perform a see-saw movement with the head, sidewise of course, until the particle is severed. Sometimes they drop back suddenly, as though it cut through before they expected it. *Query*,—Do they eat this wood to live? It seems to be so, for these *Eutermes* have had nothing but wood, water, and soil for three weeks. There are always a number resting or masticating, and always as many more feeding on the wood. I have watched them at all hours of the night, and find them the same as in the day, and can easily tell now when they are getting hungry or have not wood enough to eat. When they are short of food, they soon get short of secretions.

It puzzles me very much to find out where or how the soldiers (nasuti) feed; the workers must set a private table for them inside, of prepared wood, perhaps. They never seem to do anything but watch, and wave their antennæ up and down, right and left; they are in constant motion, however, and frequently relieve guard.

There are all shades of color in my Termitarium, from white to nearly jet black, according to the *age* of the worker, I think; the oldest and largest have the top of the head black, and the body or abdomen a dark yellowish brown. The very young and small ones are of a transparent white, and as they grow older the heads get darker and then the body. The soldiers seem to remain of the same color.

When a nest is disturbed, and there is any fighting to do, the soldiers and mature workers issue forth, while the young white

ones hide away. Hence it was the yellows or natives that issued from the block of wood on the field of battle; while in the case of the foreign or strange nest—which was only a fragment of a nest—in transporting it some distance, these older ones had dropped off on the way, leaving only the white ones in the inner recesses, and these had to be jarred out on the block. Of course there were some nearly mature, but the majority were of a lighter color,—hence I use the terms yellow and white, though all were probably the same species; and no wonder the yellows were masters of the field, being older.

To see if there was any fight in the soldiers, I placed two, from separate nests, in a clean white saucer. These soldiers are much smaller than the workers, and only discernible to my unassisted eye. The attempt succeeded, and with my glass I could see that it was a fight in self-defence when they came together. Such rapid vibratory movements, or jerks, with the beaks, could hardly be imagined, and in scurrying around one of them got a leg stuck on the saucer and could not pull itself loose, the saucer being so smooth. Looking closer, I thought it was stuck by some liquid ejected from the beak, a few small specks being visible. After being liberated, they collided again, and more spitting ensued, until their legs were entangled or stuck together, so that I used two pins to pull them apart; they appeared to be limed all over, and stuck to everything that touched them.

I have seen a common black ant attack a nasutus soldier, drop it, and go off wiping its feet and antennæ, evidently having received a dose of something sticky. It would, therefore, seem safe to say that this beak is a weapon of defence, though further examination would be desirable. I have repeated this experiment with the soldiers several times, with the same striking results. To vary the trial, soldiers from the *same* nest were placed in the saucer; these would run about all right, until disturbed by a pin, then they would go through the vibratory process, and be stuck with their own secretion.

June 3d, 1888. I have had the good fortune at last to secure to-day six queens of *Eutermes*—also eggs, soldiers, and workers, all from one nest, but did not find any winged ones there. The queens are about five-eighths of an inch long. I will forward them to you, as these are the first queens that I have seen. . . .

I hope you will be successful in discovering some simple method of circumventing the ants in their marvellous and rapid destruction of valuable property; and in this connection would suggest appealing mainly to their sense of smell rather than of taste.

June 16th, 1888. To-day notes the capture of two beautiful

queen *Eutermes* from a nest in an old car used for stores in the shop yard. I had the pleasure of taking them from their nest myself. They both lay in a cell close together. Their bodies are pure white, with dark brown bars across above and below. In another part of the nest, eggs were stored in large numbers (Fig. 7). . . .

At one time I marvelled at the numbers of ants contained in one of their nests; but now my astonishment is great at the number of the nests, and of one species only, the *Eutermes*. Some new evidence of their skill and intelligence can be daily noted. Yesterday (June 23d, 1888) I took my chair and sat down in front of a box of growing plants in my garden; the *Eutermes*

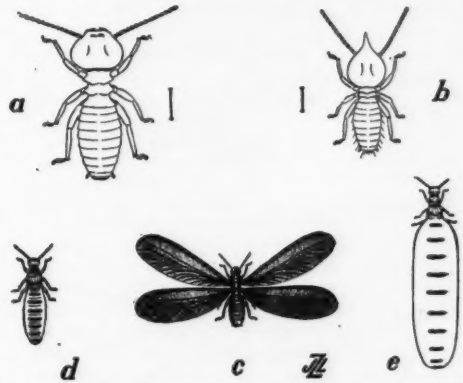


FIG. 7.—*Eutermes* sp. *a*, worker; *b*, soldier (nasutus); *c*, queen, before swarming; *d*, same after impregnation; *e*, same matured and full of eggs. *a*, *b*, enlarged five diameters; *c*, *d*, *e*, natural size.

have several tracks over the box, one of which runs along the top edge. I made a slight break in the track or gallery, and watched their movements through my lens. A worker drops off the edge of the box to the soil below; in coming up again, it runs against the track several inches away from the break, and begins at once to cut a hole in the track; in a few moments the gallery is pierced, enough for a soldier to squeeze through, and three come out to stand guard outside until the worker makes the hole large enough to admit its entrance. Presently it enters. the soldiers follow, and the workers at once proceed to seal up the hole from the inside,—the whole operation only occupying about ten minutes.

To-day I have been watching how they enlarge their nests, which they appear to do periodically, or rather as necessity requires. The nest was somewhat globular in shape, and they were making it one story higher or larger all around, by forming upon the old surface a number of cones or pillars of irregular shape, but all about the same height, a half inch or so, and then uniting or roofing over these pillars. Some were roofing, while others were raising the cones. I have sent you samples of this roofing material; it is very delicate, but answers the purpose as a protection from the sun and rain. It somewhat resembles the surface of a nutmeg grater, having minute openings, supposably for ventilation.

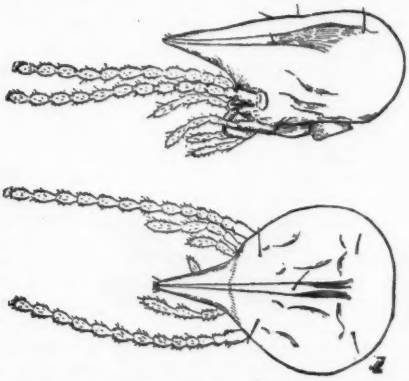


FIG. 8.—Head of *Eutermes* soldier (nasutus) enlarged 25 diameters, seen sidewise and from above. Five tactile hairs are shown; and the interior tube or "gun" is visible through the chitine of the head.

One of the functions of the *Eutermes* soldier seems to be to act as a guard to the worker, and it ejects a glutinous liquid, probably from the beak, in self-defence or when alarmed (Fig. 8). It still puzzles me how and upon what it feeds. I can find nothing inside their nests, no fungous growth, and am ready to believe that they are fed by the workers. This will be a difficult point to settle, for without doubt they are fed inside the nests.

June 23d, 1888. While walking in front of our new roundhouse this afternoon, I detected the ants at work on one of the posts, and saw at a glance that it was the species mentioned as No. 3, *T. testaceus* L., the same that completely destroyed

my office window. This insidious little worker has not been credited with its full amount of destruction, and therefore should receive some notice, especially as you ask "whether the *Eutermes* do most of the damage, according to my observations?" Two months ago I should have replied in the affirmative, but *now* shall be cautious in answering.

I have sent you a full description of the species, and specimens of their soldiers, workers, and winged ones, and also their nests and work. They labor in a different manner entirely from the *Eutermes*, working endwise into the heart of the wood, keeping out of sight and away from the surface, so that they can only be detected by an experienced eye. For this reason they are the more dangerous of the two species, and the kind which destroyed the tie-beams, a sample of which I sent you. Since then, I found a nest of them in the heart of a yellow-pine post; the nest continued twelve inches below the surface of the ground, and below that the post was sound. Samples of their work are quite a study, and I have a good collection of them. I have not yet found a queen of this variety, and you quote Dr. Hagen as saying "a queen of this species has never been seen." So far I have only observed their work upon buildings.

I feel very much indebted to you for intelligent help in directing my studies of the Termites. Your conclusions are right in regard to the loss of the antennæ. I noticed the peculiar movements of a worker in the Termitarium after having a battle. It was walking about with its head drawn around to the left, and seemed very awkward. Then I saw that the left antenna was cut off during the fight. The other workers seemed to sympathize with it, and gave it considerable attention.

I frequently observe the workers apparently washing or cleaning each other; the soldiers never do this, though they receive the same attention. This operation takes place during the period of rest. In my Termitarium there were always some at rest; and this must be one of their habits, as I find them in their tracks and galleries whenever they are broken, either day or night; and otherwise these would be sometimes found empty.

The charming book of Sir John Lubbock's, "Ants, Bees, and Wasps," which you kindly sent, came to me all right, and its contents were eagerly read. Please accept my sincere thanks. It will be a great help to me, and stimulate me to further effort in studying the Termites. I have the best opportunities all around me for making observations; in fact, the subject presses itself upon my notice every day in some way or other, and the study grows more and more fascinating. Sir John Lubbock's work is the first authority on ants that I have seen, and I am pleased to find that many of my observations are corroborated by him.

I find the species *Termes testaceus* L. far more numerous and destructive than I at first conceived, but have only found them attacking the framework of buildings and fence-posts when the wood is partially decayed. They have entire possession of the sills of our new round-house, erected only two years ago; in some places they have nearly eaten through the sill, commencing between that and the weather-board. They construct galleries from the ground up to the wood-work, of a somewhat different form from those of the *Eutermes;* but having once entered on their work of destruction, they keep more concealed from observation, having always a connection with the soil. A few days ago, I had the sill bared, and showed it to our General Superintendent, Col. Rives, and he was astonished that such destructive work could be done in two years, even by the united work of fungi and wood-ants. I cut out a short section of this yellow pine 8x8 sill, and it looks even worse than the sample of tie-beam sent to you. I think it is the same colony of *Termes testaceus* L. that is still at work. They are more difficult to exterminate than *Eutermes.*

Your original and useful study of the decay of woods gave so much value to your advice that some treated lumber has been ordered for our use. This is a step in the right direction to prevent the destructive effects of fungi and wood-ants in this exceptional climate. I venture to assert that the Panama Canal and Railroad Companies are losing thousands of dollars of valuable material annually from the lack of proper attention to these two destructive agents alone. I am satisfied that if the lumber imported here was prepared with some antiseptic to resist the growth of the fungi, the wood-ants would give it a wide berth. Such a method would not only lengthen the life of our cars and buildings, but greatly reduce the expense of keeping them in repair.

July 4th, 1888. I send you a package to-day containing four different species of wood-ants, found at work on our shop buildings. The contents of vial No. 1 are immature winged *Eutermes,* two queens, with some eggs, soldiers, and workers; No. 2 contains winged *Termes testaceus* L., soldiers and workers; No. 3 contains soldiers and workers of the smallest kind yet seen, which I am unable to name; No. 4 contains winged *Eutermes,* soldiers and workers; No. 5 contains winged ones, soldiers and workers.

You call my attention to some of the worker *Eutermes* having darker heads and bodies than others. This difference, I observe, is common in all the nests examined, and I think it entirely due to age. The youngest and smallest are of a transparent white, and shade to those having dark-brown bodies and black heads.

I have been observing the use they make of the antennæ, by causing a large drop of water to fall on a worker, which completely covered it for an instant, and made its antennæ curl up and stick to its head. It moved aimlessly about, apparently blind, until another worker, noticing its helpless condition, commenced at once to lick it dry, and then straightened its antennæ, upon which it walked away as though nothing had happened. Very different was the next experiment. I immersed in water for about two minutes another worker, then took it out, and laid it on dry paper a moment, then returned it to the Termitarium, placing it on a chip. It was just able to stand. Four soldiers were first to approach and notice it; one ran to the nest, the other three stood at a distance of about three-eighths of an inch, waving their antennæ, evidently smelling that something was wrong, but careful not to touch it. Presently a worker came out of the nest and cautiously approached, touched it with its antennæ, then gave it a cruel nip with its mandibles on the head, and went away. The poor sufferer remained motionless all the time, apparently blind and not knowing what to do. A second worker came, approached cautiously, as did the first, and touched it with its antenna, then suddenly seized it by the thorax and severed its head, without a struggle. The head rolled off the chip; the executioner then turned around and deposited a drop of the ever-ready cement on the headless body, and deliberately walked away. There was no excitement or alarm, and the nest was not disturbed; they did not treat it as a stranger or an enemy. *Query*—Did they kill it to end its misery? And why did they treat it so differently from the one not immersed? . . .

July 15th, 1888. I have successfully established another novel Termitarium. I desired an arrangement that would afford me facilities for observing their internal habits, as to the way in which soldiers were fed, and how the workers cut and masticate the wood upon which they feed. My success has been beyond my expectations, though some of the conclusions will need confirming by further and, if possible, more careful observations. Others are established facts that may, as you say, destroy some present theories.

I have increased the power of my lens by uniting two small ones: a worker, under this combination, appears to be about five-eighths of an inch in length. With this lens and my new Termitarium, I have been able to see without obstruction:—

The workers feeding the soldiers, and

The workers feeding each other, on masticated particles of wood;

I have actually seen the particles pass from one mouth to the

other; have noted the time taken to cut a cube of wood from the feeding-boards; have observed them masticating the same wood; and noted the number of times that the mandibles open and shut per minute while masticating.

On one occasion I could distinguish the minute saw on the left mandible. . . .

This Termitarium is made of two glass fruit-dishes,—the largest eight inches diameter by four and one-half inches deep, the other or upper story six inches by three and one-half, with flaring sides. You will notice that I can look directly down upon the ants on the feeding-boards. I can also, on one side, look directly into the upper retiring-room, and see the thousands congregated there,—some sleeping, others masticating, and some feeding and washing each other. They have chosen to leave the old and exposed nest on the lignum-vitæ block, and gone through the perforations to the secluded retiring-room below, just as I desired and expected. The Termitarium contains a population of from five to ten thousand. Their time seems to be chiefly occupied in sleeping, eating, "hewing wood, and drawing water" from wells dug in the soil when not otherwise provided, making galleries, and arranging earth-works in the retiring-room, the nature of which I do not yet understand.

When a worker has severed a particle from the feeding-boards H, H, it usually goes to the retiring-room, D, to masticate, and then feed to others,—soldiers and young workers,—and, if necessary, to itself. Then it commences at once to masticate on the board. Here it will perhaps be met and robbed of the morsel of wood by another worker, the latter deliberately pulling it from the other's mandibles. The only resistance offered is a tug, that perhaps results in an equal division. Then both proceed to masticate. In a moment or two, according to the size of the piece, they will be ready for work again, and all the time perfect harmony prevails, one yielding to the other good-naturedly. When a worker has secured rather a large mouthful, it will twist and turn its head, while masticating, much as a cow does with a large slice of a turnip in its mouth. The mandibles open and shut about forty times a minute by the watch, the particles of wood meanwhile being turned by the maxillæ and palpi every time the mandibles are opened.

I noticed further about their habit of licking each other. I have seen four workers at once washing another worker, and observed another washing a soldier. After the body was done, the soldier held out each leg in succession to be cleaned. The fact of their beak being in the way,—and no mandibles,—prevent their "hewing and drawing," so that they seem to have an easy time of it, being fed and cleaned by the workers.

With the aid of the lens, I picked up on the point of my pen a small particle of wood that a worker let fall ; it will give you an idea as to size, though I have seen them have larger pieces. It is gummed to the inclosed sketch, and the spot is marked thus ⊙. You will have to use your lens. I consider this remarkable, and hope you will receive it all right.

While at Gatun Station, a few days since, I obtained two specimens of separate nests of the species No. 5 in my last package to you. On opening one nest, I found one-half of it occupied by an entirely different species—a black ant, not a Termite. There

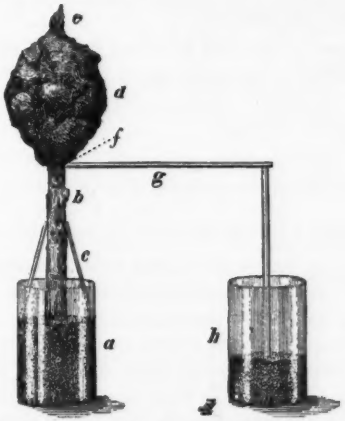


FIG. 9.—Improved Termitarium of Mr. J. Beaumont. *a*, glass jar, 6 × 9 inches, filled two-thirds with earth; *b*, *c*, small tree-stem, fixed into the soil and bearing a sub-globular nest of *Eutermes*; *c*, *c*, braces to steady it; *d*, nest, 10½ inches long, and raised 18 inches above the earth in the jar; *f*, opening made in the nest, from which the "bridge," *g*, leads to the "annex jar," *h*, partly filled with soil. When in use, the jars are placed in vessels partly filled with water, to prevent escape.

were the eggs, larvæ, and winged ones of the black variety. In the other half, occupied by the Termites, were larvæ also—doubtless their own. Here also, to my surprise, were the tracks of those called *Termes testaceus* L., on a fence-post, but no nest visible. While riding over the Panama Railroad during the week, I noticed the well-known tracks of the *Eutermes* running up the whole length of a creosoted telegraph pole. It will be interesting to know whether they will penetrate wood so prepared. There was also a green surface growing over the north side of these poles. I have since been told that these poles were not

filled with genuine creosote, but some preparation of crude well-oil. Can you enlighten me on this point?

I hope you are not tiring with my notes about my pets, for believe me, the half has not been told of their winning ways.

February 11, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Fifty-five persons present.

A communication was read from the Royal Bohemian Society of Sciences in Prague, announcing the death of the President of that body, Mr. Joseph Jirecek, on November 25th, 1888, in the sixty-fourth year of his age.

The second lecture of the public illustrated course was then delivered by Professor ALPHEUS HYATT, of Boston, upon

MODES OF EVOLUTION IN FOSSIL SHELLS,

with an extensive series of lantern views, showing the nature and variety of modifications in species and groups.

The lecturer gave a few preliminary remarks on the meaning and general bearing of the doctrine of evolution, in which he held that this word is properly applicable to all kinds of variation into new life-forms, as well retrogressive as progressive, and objected to the use of such terms as "avolution," or the like, as proposed by some writers who would limit the idea of evolution to an implied advance. He followed these observations by showing stereopticon figures of his series of shells of Planorbis collected at Steinheim, in Germany. These illustrations gave the audience, in a succession of views, the evolution of a number of distinct forms, which had arisen from four varieties of one species, *Planorbis levis*. This species was almost equilateral, the whorls revolving nearly in the same plane during their growth. One of the series evolving from this form gave rise to a large turbinated variety resembling what are usually called Trochiform shells. Other series were less changed, though showing a tendency to evolve into similar

forms. Still another series had changed so little that the lecturer spoke of it as a persistent type; while other series which followed these, but sprang from the same common source, evolved into diminutive, degraded, and distorted shells, more or less uncoiled.

The lecturer applied the laws of evolution, which could be seen to have governed the development of these different series, to the evolution of life-forms in general in the history of the earth. He then showed a series of views exhibiting the different stages of growth of the shell in the living *Nautilus pompilius*, and illustrated the laws of heredity and biogenesis by projecting on the same spot on the screen which had been occupied by the figure of the young of Nautilus the figure of the full-grown adult of a Silurian fossil, Cyrtoceras. The likeness was clearly perceptible to the audience, and was close enough to demonstrate the reality of the correspondence between the young of the existing species and the adult of its ancestor, which lived only in the most ancient periods of the earth's geologic history.

MR. FREDERICK BRAUN exhibited further illustrations of the same subject, after the lecture, in a number of specimens of fossil shells, selected and arranged in sets to show relations and changes.

A vote of thanks was unanimously tendered to PROF. HYATT for his able discussion.

February 18, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-five persons present.

DR. FRANZ BOAS exhibited a number of photographs of tattooed Indians from the Queen Charlotte Islands, B. C. This people, the Haida, are the only one in the habit of tattooing their whole bodies,—wrists, arms, breast, back, legs, and feet,—the designs being conventional representations of animals, the "crest" of the person on whom they are tattooed. The tattoo-

ing is done by puncture and by rubbing soot into the wounds. The patterns are exactly analogous to the paintings and carvings of those people. Tattooing is not unknown to the neighboring tribes, but chiefly confined to marks on the wrists and eventually on the ankles. Such designs are found, for instance, among the Tsimshian. Tattooing on the arm and breast is also found among the Nutkas of the west coast of Vancouver Island, but in this case it is connected with religious practices, not with the social organization,—the totems of the people,—as it is among the Haidas. A photograph of a Nutka was exhibited, showing a human figure on the breast. The same individual had long, parallel cuts running from the collar bone down to the belly, and from the shoulders all along the arms. These wounds are inflicted at the initiation of the young man into a secret society and are called "Tlo-koala," a word borrowed from the Kwakiutl language.

Besides these photographs of tattooed men, others illustrating a few types of Indians were shown, and attention was called to the broadness of their faces, the light color of their skins, and the shortness of their heads. Deformed heads are found only as far north as Milbank Sound and Gardner Channel. A few photographs of excessively deformed heads from the north point of Vancouver Island showed the effects of bandaging, which results in a great elongation of the occipital part of the head.

Replying to a question of the chairman, DR. BOAS stated that the style of art of the northern Tlingit, the Haida, Kwakiutl, Nutka, and Salish can be easily distinguished. He believes that certain designs originated among the Kwakiutl, but reached their highest stage of development among the Haidas. The Salish have some peculiarities not shared by any of the other tribes.

THE PRESIDENT referred to his own observations on the carvings among some twenty tribes of that region, and to the artistic skill displayed by those along the coast, whose work bears a decided resemblance to that of the races of Central America,—possibly indicating a genetic relationship,—and contrasts strongly with the inferior skill in carving shown by the inland tribes of our Northwestern territory.

The following paper was read by title:

A NEW GENUS OF TERMITOPHILOUS STAPHYLINIDÆ,

by THOMAS L. CASEY.

In this article, published in the ANNALS, Vol. IV., pp. 384–387, CAPTAIN CASEY describes, under the name of *Termitogaster insolens*, a very curious staphylinide form found in the nests of certain species of white ants on the Isthmus of Panama, and brought by Mr. Dudley.

It is defended against injury from the Termites among which it dwells, apparently by "protective mimicry," its elytra being short and inconspicuous, while its abdomen is rather distended, white, and soft,—the whole insect bearing a strong general resemblance to a white ant.

The paper announced for the evening was then read by MR. WILLIAM L. ELSEFFER, C.E., as follows:

ON THE TENDENCY TO CONTAMINATION IN ARTIFICIAL PONDS, IRRESPECTIVE OF VOLUME; WITH APPLICATION TO THE QUAKER BRIDGE DAM.

There are three conditions to be considered, namely: (1) stagnant water in artificial ponds; (2) contamination originating from stagnant water; (3) impurities carried into the pond from above and settling upon the bed, and thus becoming a source of contamination.

There can be a current through a pond not necessarily commingling with the entire body of the pond. The standing water or undischarged volume of a pond will be of different density and quality from the limpid inflow running over a rocky and gravelly bed.

Where the outflow is limited,—the outflow being always greatly less than the volume of the pond,—the current through the pond cannot have sufficient volume to mingle these waters of different condition and density;—the cohesion of the current volume being stronger than its adhesion.

Water will flow between walls of water, as the Gulf Stream through the Atlantic, and as the Hudson River on change of tide (the flow in mid-river continuing for some time up or down stream as the case may be, while on both sides the flow is in an opposite direction), or as a small stream discharging into the

sea, when a wave causes the bottom layers to flow up-stream while upon the top the current continues down-stream.

In 1859, I was called to gauge the natural flow of a stream upon which were three mills at intervals of about four miles. The lower mill depended for its power upon the natural flow; the two other mills depended upon dams. On one occasion, the upper mill had been idle for several days, and the water overflowed the weir. The vegetable matter in flotation made it evident that a well-defined current existed through the pond, while beyond the current laterally there was no real flow.

In any artificial pond it is natural that there should be a stagnant belt.

In the idle mill-pond here referred to, it was observed that the water had a discoloration and also an objectionable taste, and that both of these extended to the whole body of the pond;—thus proving that the impurities of the stagnant parts of the pond can be taken up into the water of the current. Fish taken from the pond, after being cooked, had the same unpleasant flavor. The water of the stream above the influence of the impoundment was clear and agreeable to the taste. The discoloration and peculiar flavor of the water, it is believed, were derived from organic growth and decomposition in the stagnant portion of the pond.

Inflow and outflow must cause a current through the projected Quaker Bridge reservoir; but the amount of outflow being limited, the current volume through the pond must also be limited. The undischarged mass must continue in a different state from that of the current volume that is directly impelled to flow. Quiescence and flow must be natural conditions co-existent in the pond.

The eminent Dr. John C. Peters, of this city, in his testimony before the Aqueduct Commission, is reported as saying that "there is no danger of any stagnation at all." This is all that he is stated to have said upon the very interesting and important subject of stagnation in the projected Quaker Bridge Dam. What has already been remarked would seem to determine that Dr. Peters is in error. Were it shown that there must be a region of stagnant water in the projected Quaker Bridge Pond,—would he still decide in its favor?

Water has the power—whether in flow or not—to take up impurity from any deleterious substance with which it is in contact. It is not intended that the main volume of the great pond at Quaker Bridge shall ever be discharged. Contaminations, therefore, carried into it from above and settling upon the bed, will there remain, a source of impurity and injury to the entire waters of the pond. Vegetable matter falling to the

bottom will be in contact with stagnant layers; and here will be the precise conditions for creating new contamination.

An incident came under my observation several years ago which serves to show the effect, upon pond-waters, of organic decomposition. It was an ancient pond covering more than a score of acres. The bed, to the depth of about five feet, was of soft black mould and fibrous material, upon a gravelly bottom. The pond was drained to make way for improvements. Several families had lived close to it; three generations were sallow and saturated with malaria and fever. The withdrawal of the water from the pond caused their wells to run dry, which compelled a lowering of the wells. Thus water was obtained from another and purer source. After the pond was drained and the wells deepened, the people of this humble community were healthier than for thirty years. Here we see that filtration of contaminated pond-water through gravelly soil does not effect its purification.

Some time ago, while walking through the Park, I observed workmen gathering deposits from the bed of the westerly compartment of the old reservoir. It was a dark, soft substance, of offensive odor, and was being carted away to be used as a fertilizer. Deposits of this sort, when allowed to accumulate upon the bed of any pond for a series of years, would become a source of abominable contamination.

There is no question but that New York could build a wall high enough and strong enough to impound all the waters of the Croton, and if necessary line the bed with metal to prevent escape of water through fissures. But further than this, the stone and cement engineers who calculate the amount of the masonry and the number of gallons it will impound, are no longer helpful. They have certified that only by means of this great dam will it be possible to serve the Croton to New York City. Yet to the philosophical engineer it is well known that by another method the supply can be made equally ample, and without creating conditions of contamination.

DISCUSSION.

MR. FRANCIS COLLINGWOOD remarked:—

MR. PRESIDENT:—I have had no opportunity to make any preparation for discussing the paper we have just heard, but cannot allow it to pass unchallenged.

The writer has attacked the project for a dam at Quaker Bridge, on the ground that the reservoir thus formed will have insuffi-

cient circulation and the water will become stagnant; he even speaks of strata of water which will remain unchanged.

Now, we are in the habit of considering a pure mountain lake to be one of the very best sources from which to seek a water-supply, and no question is raised about lack of circulation. The fact is that it is *impossible* to keep such water still. It is subject to the laws of heat, and there is a constant interchange going on between the water at the bottom and at the surface. Then it is constantly fanned into ripples by the winds, or lashed into waves by storms.

The proposed reservoir will be a genuine lake, about 17 miles long and, except at the extreme upper end, very deep in proportion to its width.

As to the upper portion, the building of the Muscoot dam now in progress will remove the objection which might be urged from this source, by preventing the drawing down of this portion except in case of emergency.

The Tyrnwy reservoir for the supply of the city of Liverpool, by the building of which one or more villages were submerged, is a case in point precisely similar to this,—viz.: the occupation of an agricultural valley by a reservoir.

But the engineers have not left the important matter of circulation to chance. In arranging for the withdrawal of water, the several inlets are fixed at such levels that it can be taken from near the surface or from any point below; and, if necessary, the whole reservoir could be emptied. Also, by a special system of conduits, either of its three sections can be drained without entirely emptying the other two.

It is a confession of weakness to argue that because no such dam *has* been built, therefore it should not be. With our present knowledge, the question is simply one of expense. Recent examinations have discovered a little lower down a still better site than that originally fixed upon,—one where the rock is found to be continuous and nearer the surface. This removes one of the doubts which have been expressed respecting the foundations of the proposed dam.

The question of strength is a simple one when compared with many other problems in construction; and there are plenty

of men who are competent both to design and to carry out the work.

Another bugbear is, that a possible earthquake may cause the destruction of the dam, and that New York and adjacent cities will be flooded and destroyed. It is undoubtedly true that the breaking of any reservoir cannot occur without damage to property and danger to life; but should such arguments prevail, no reservoir would ever be built.

It can, however, be readily shown that if all the water of the proposed reservoir should be suddenly discharged, except that which would be held back by the old Croton dam and the Muscoot dam, the increased depth of water at New York would probably not be sufficient to overflow the bulkheads.

Aside from this, the probabilities are in any case all against such a break occurring as would allow the whole volume to escape at once; and with a properly constructed dam, there is no reason to anticipate any failure whatever.

As to contamination of the water by residents on the watershed, that danger can be provided against, as has been successfully done at Rochester and elsewhere. Having gone to the great expense of building a conduit of ample proportions to transmit all the water of the Croton water-shed, let us not, through unfounded timidity, stultify ourselves by failing to carry out the scheme in its entirety.

PROF. A. A. BRENEMAN said: The standing objection to storage reservoirs is the sediment of organic matter which collects in them and acts as a hot-bed for animal and vegetable life, which further defiles the water. Such sediment is difficult to remove, and the weight represented by a depth of one foot of it over a single acre will surprise any one who will make the calculation. It has been shown by the late Prof. Nichols that the influence of the direct rays of the sun may penetrate, as heat, to the depth of thirty-five feet in water. As temperature is the principal factor in the decomposition of organic matter in these deposits at the bottom of a reservoir, it is evident that such a reservoir should be more than thirty-five feet in depth. Light, of course, goes deeper, and the changes of temperature due to circulation of water probably also extend much farther

than thirty-five feet; nevertheless the direct transmission of the sun's heat and light is the source of most active decomposition and organic growth. As the proposed Quaker Bridge dam is to be very deep, it will be proportionately free from objection on this score.

But there is another characteristic feature of Croton water, in regard to which the depth of the proposed reservoir will be of very little effect. Our city water is originally a peaty water, as may be seen in the streams of Westchester County which supply the Croton system. The brown color of these waters disappears on oxidation, but it requires very prolonged action of air, and probably of sunlight, to remove the color to any great extent. In fact the water is never entirely colorless, or nearly so, if it be observed in a layer as little as one foot in depth. As we draw it from faucets in the city, the color is usually perceptible, even in an ordinary goblet, and often quite pronounced. These variations in tint, apart from the mere cloudiness or muddiness due to suspended matter, are dependent upon temperature, rate of flow, and especially upon season, the depth of color being greatest in autumn. The latter fact is probably due, in part, to decay of leaves, but also to acceleration, by heat, of the decomposition of peaty matter, through which soluble products are formed; and this result is an accumulated effect which is most apparent only after the summer has closed. The Central Park reservoirs are almost as brown at times in the fall as the waters of the Croton or its tributaries. Now, the surface of water exposed to air and light—and therefore the facilities for oxidation—will be less in a deep reservoir, in proportion to the volume of water, than in a shallow one. We cannot therefore expect any improvement in the *color* of Croton water, as we receive it in the city, from the building of the great dam.

Again, the suspended matter of Croton water differs very much in character at different seasons. In winter it is comparatively trifling in quantity; in spring it is more abundant, often excessive, but made up principally of suspended clay, or clay made flocculent by small quantities of organic matter, which readily subsides. In summer, especially late in the season, however, it is largely organic, and is so light and flocculent that much

of it remains suspended for many days, or indefinitely. Settling-reservoirs will not do much to purify water at such times, the times of all others when purification is most needed; and there is nothing that will do so except filtration. The question of the Quaker Bridge dam rests so largely upon matters of engineering, that it will probably be decided, ultimately, more upon such grounds than upon any other; but it is well that we should know exactly what can and what cannot be expected of it in the matter of improving the *quality* of Croton water.

Mr. Orlando B. Potter made remarks upon some of the difficulties and objections connected with the proposed great reservoir, and favored rather the construction of a number of smaller basins, by building dams in the valleys of tributary streams. He referred also to the ultimate inadequacy of the Croton water-shed for the needs of the future metropolis, and suggested, in that event, an extension of the Westchester aqueduct system into Connecticut, so as to reach and utilize the streams flowing into the Housatonic.

Dr. A. A. Julien spoke of the organic growths that tend to contaminate reservoirs and ponds, and pointed out their usual occurrence in shallow waters and near the surface. A large deep body of water, such as the proposed Quaker Bridge reservoir, would in this respect have much advantage relatively over smaller and shallower ones.

Dr. Newberry remarked that there was much to be said on both sides of the question of the Quaker Bridge dam. It was undoubtedly true that the water supplied to the city would be purest if it could be stored in deep rock-walled reservoirs like some of our lakes, Mahopac, Mohonk, and others. In such deep reservoirs the water would be kept relatively cool, would be clarified by the settling of suspended impurities washed in in time of flood, and if the outlet were near the surface such impurities would be left undisturbed. Again, the animal and vegetable organisms which in their decay contaminate drainage waters are confined for the most part to shallows where the depth of the water is fifteen feet and less, and where it is warmed by the sun's rays. The Quaker Bridge dam would have more

the character of a lake reservoir than would any of the local basins which it was proposed to establish in different parts of the water-shed. These would be shallower and warmer, and therefore would contain a greater amount of animal and vegetable life. On the other hand, the construction of the Quaker Bridge dam presented serious engineering difficulties; much of its foundation must be laid in the bottom of the ancient channel of Croton River, one hundred feet below the present water-surface. The engineers tell us this could be done, but it would be at a great cost. It would also be necessary that the dam should be made very strong, since much of it would be a wall one hundred and forty feet high and one which must resist an enormous pressure, especially at the time of floods. This also the engineers tell us could be accomplished, but it would cost money.

It has been suggested that a structure of this kind might be destroyed by an earthquake like that of Charleston, and such as may possibly affect the country about New York at any time. The chances of such an event may, however, be considered small; and if properly constructed with a heavy embankment above and an equally heavy apron below, the dam would be for the most part subterranean, and only the upper part would be likely to be thrown down; and any earthquake which would destroy the dam would so completely destroy the city that the loss of the dam would be of comparatively little consequence.

The construction of a number of local reservoirs would probably cost less than one great one, near the mouth of the Croton, and they might be built in succession, as needed; so their cost would be distributed over many years. The suggestion of Mr. Potter, that when the supply furnished by the Croton basin became inadequate the head waters of the Housatonic could be utilized, is an important one, and with the rapid growth of the city must before many years be adopted. The wants of a population of four or five millions must be considered, but fortunately they need not be provided for at once. As the water consumption increases it can be supplied by an extension of our aqueduct system to the upper part of the Housatonic basin or even to the Adirondacks.

Whatever plan for the increase of the water-supply in New York may be adopted, provision should be made for cutting off the sources of contamination which now exist, and will inevitably multiply, along the line of drainage from which our water-supply must come. I refer to the farms, and particularly the dairy and stock farms, which lie within the Croton basin. The contamination produced by the drainage of such farms can be prevented by two methods: either the city must control these farms and change the character of the drainage from them, or it must bring the water from reservoirs beyond the farming districts, in pipes or aqueducts from which the local drainage is excluded. Either plan would involve great expense, but it would be a necessary expenditure and one which a great and wealthy city could afford.

The subject was further discussed by MR. CHITTENDEN, DR. JULIEN, and others.

February 25, 1889.

ANNUAL MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-nine persons present.

The annual reports of officers and standing committees were presented as follows:

REPORT OF THE TREASURER.

DR.	To expenses of Recording and Corresponding Secretaries	$61	92
	" expenses of Librarian	61	41
	" " " Treasurer	10	92
	" " " Publication Committee	142	80
	" " " janitorial service	37	00
	" " " collation at Reception	85	00
	" insurance	35	00
	" wrapping, directing, and expressage on publications	43	91
	" salary to Editors of Annals and Transactions,	550	00
	" engraving and printing of plates, etc.	70	75
	" printing Annals, G. Gregory	478	25

Dr.	To printing Transactions, Stettiner, Lambert & Co	$1,096 84
	" miscellaneous printing, G. Gregory	132 00
	" " " Gilliss Bros. & Turnure	38 50
	Total expenses	$2,844 30
	Deposited in Merchants' Clerks' Savings Institution	1,470 00
		$4,314 30
	Balance to new account	380 39
		$4,694 69
Cr.	By balance from last year	$1,172 14
	" interest on U. S. Bonds	164 00
	" sales of Annals and Transactions	43 55
	" initiation fees of new members	140 00
	" fellowship fees	30 00
	" seven life members' fees	700 00
	" one patron's fee	250 00
	" annual dues	2,195 00
		$4,694 69

The invested funds belonging to the Academy are the following:

U. S. four-per-cent "consols"	$3,800 00
U. S. coupon bonds	300 00
Deposited in M. C. Savings Inst. (as above)	1,470 00
	$5,570 00

The Treasurer's report was accepted in due form.

REPORT OF THE LIBRARIAN.

(Abstract.)

The Librarian reported additions during the year of 1,370 volumes and parts.

The work of binding has been carried on; there having been bound by the Academy 97 volumes,—received prior to the engagement with the Library of Columbia College,—and by the latter, under the agreement with the Academy, 37 volumes; while 80 volumes more are now in process of binding.

The report acknowledged the receipt of a new and complete card-catalogue of the bound volumes, furnished by the authorities of the Columbia College Library; and recommended a further appropriation to continue the binding of material received prior to the arrangement with the College.

The report was approved and adopted.

REPORT OF THE CORRESPONDING SECRETARY.

(Abstract.)

The Corresponding Secretary reported as follows:

New corresponding members elected	13
Transferred from resident membership	7
	20
Deceased	2
Transferred to resident membership	1
	3
Net increase in corresponding membership	17
Total number of correspondents	331
Societies in correspondence and exchange of publications	411
Of which there were added during the year	24
New honorary members elected	10
Deceased	3
Remaining on the roll	46
Vacancies at present	4

The report was approved and adopted.

REPORT OF THE PUBLICATION COMMITTEE.

PROF. D. S. MARTIN, chairman, reported the issues during the year as the following:

(I.) Transactions, Vol. VII., concluding parts, with index to the volume.

(II.) Transactions, Vol. VIII., Nos. 1 and 2; and also Nos. 3 and 4 in press and soon to appear.

(III.) Proceedings, index to Series I. and II., thereby completing those partial issues after much delay.

(IV.) Annals, Vol. III., index.

(V.) Annals, Vol. IV., Nos. 5 to 9 inclusive; and also Nos. 10 and 11 in press and soon to be out.

(VI.) Also, the reprinting, as ordered in the spring by the Academy, of several parts of back numbers of both Annals and Transactions, which were out of print and were required to complete sets for binding and exchange.

About half of this work, comprising items Nos. I., III., and VI., had been done under the direction of the late editor of the Transactions, PROF. FAIRCHILD, and the remainder by the present editor, the chairman.

The report was accepted and adopted.

Owing to the recent changes in the office of Recording Secretary, no formal report was presented from that department. But the Academy's meetings and lectures had been maintained with regularity and interest; and the character of the communications and the size of the audiences had been fully equal to those of previous years.

COMMITTEE ON THE AUDUBON MONUMENT.

DR. N. L. BRITTON reported progress in behalf of this Committee, referring to the adoption of the proposed design for the monument; the removal of Mr. Audubon's remains by the cemetery authorities to the new plot assigned; the preparation by them of the ground to receive the monument; the various circulars issued by the Committee, etc., etc. As yet, the amount received was by no means adequate to erect a monument such as was designed and desired; and further efforts were needed to accomplish the result.

The report was accepted, and the Committee continued.

ELECTION OF OFFICERS.

The recent death of MR. H. LOWELL ELLIOTT, whose name had been placed on the ticket previously presented by the Council, as one of the Curators, rendered a special election necessary to fill that place.

A ballot was taken, and CAPTAIN THOMAS L. CASEY was chosen as nominee on the regular ticket.

No other names having been presented for any of the offices, the Academy proceeded to the Annual Election; and MESSRS. BASHFORD DEANE and HENRY DUDLEY were appointed tellers. Their report showed the election of the Council's ticket unanimously, save a very few scattering votes; and the following officers were thereupon announced as chosen for the year:

President, JOHN S. NEWBERRY.
First Vice-President, OLIVER P. HUBBARD.
Second Vice-President, WM. P. TROWBRIDGE.
Corresponding Secretary, ALEXIS A. JULIEN.
Recording Secretary, H. CARRINGTON BOLTON.
Treasurer, HENRY DUDLEY.
Librarian, NATHANIEL L. BRITTON.
Councillors, J. A. ALLEN, P. H. DUDLEY, A. R. LEEDS, D. S. MARTIN, J. J. STEVENSON, C. VAN BRUNT.
Curators, FRANZ BOAS, BASHFORD DEANE, THOMAS L. CASEY, GEORGE F. KUNZ, JOHN J. NORTHROP.
Finance Committee, JOHN H. HINTON, S. B. BROWNELL, L. E. CHITTENDEN.

THE PRESIDENT addressed the Academy, acknowledging the compliment of his re-election, referring to the highly favorable condition of the finances, and briefly reviewing the past history and growth of the Society. He dwelt upon the still-existing need of a permanent building for the Academy, and held this to be the object toward which all its growth and all the hopes and endeavors of its officers and membership should be directed. He referred to certain important plans for that end which were now under consideration, but not mature enough for public discussion at present.

MR. JAMES T. B. IVES, as announced, then exhibited a geological strata-map which he had constructed for the use of teachers of science. A series of differently colored sheets, cut to the shape of the outcrops of the several geological eras and ages in any given region, are hinged in such a way that, when

superimposed, they present the aspect of an ordinary geological map, and can then be turned down separately, so as to show the entire area actually occupied by each formation, although, in fact, covered more or less by later ones. He explained the construction and use of the map, and the various points of geological structure which it can be made to elucidate.

The apparatus was much admired by the members, and was discussed by the PRESIDENT, PROF. MARTIN, and others.

March 4, 1889.

REGULAR BUSINESS MEETING.

The Academy met in the Chemical Lecture-room of the School of Mines building, for the sake of certain facilities in the use of apparatus for experimental illustration of the lecture.

The President, DR. NEWBERRY, in the Chair.

A large audience was present.

The Report of the Council was presented, containing only a few minor items of business, which were unanimously approved.

The third Public Lecture of the season's course was then delivered by PROF. W. LE CONTE STEVENS, of Brooklyn, upon

THE DIFFRACTION OF SOUND.

(Abstract.)

The lecturer gave an introductory sketch of the development of the wave theory in its application to sound and light, as brought out by Lord Bacon, Galileo, Newton, Hooke, Huygens, Young, Arago, and Fresnel. With the experiments of these physicists he contrasted the speculations of a small but persistent modern school, who have been endeavoring to overturn the wave theory and to substitute the so-called "substantial" theory. If sound or light can be propagated by the "emanation of an immaterial substance," its immateriality removes the consideration of it from the domain of physical science, which is concerned exclusively with the laws of matter and motion. No answer from any

physicist therefore can ever be expected for the "substantial" theorists.

Huygens' principle, that a disturbed particle in an elastic material medium must necessarily become a centre from which wave motion is propagated spherically in all directions, was illustrated; and a discussion was given of its application to the phenomena of diffraction, which constitute a crucial test of the wave theory, whether this be applied to sound, heat, or light. For exhibiting diffraction of light, special apparatus is needed; but, on account of the extreme shortness of light-waves, measurements of great accuracy can be made upon them. By the use of a diffraction grating, the lecturer projected a luminous spectrum on the screen, and gave the familiar computation for the length of a wave of red light. Sound-waves are so long that their diffractive encroachment on sound-shadows almost masks the existence of such shadows. To define these, and to make even coarse measurements upon the diffraction of sound, tones of very short wave-length are needed, and consequently of such high pitch and slight intensity that audition becomes difficult.

An account was given of observations made on sound-shadows in water by Colladon in 1826, and Le Conte in 1874; also of sound-shadows in air due to dynamite explosions. Lord Rayleigh has recently made some remarkable experiments on diffractive effects upon aërial sound-shadows, using a high-pitched whistle as a source of sound, and a sensitive flame as an indicator.

The discovery of sensitive flames by Le Conte in 1857 was then recounted, and also the subsequent development of this indicator by Barrett, Tyndall, and others. The sensitive flame was exhibited, and all of the experiments thus far published by Lord Rayleigh were repeated. Quite sharply defined sound-shadows were produced, wave-lengths in open air were measured, the theory of the diffraction-grating for sound was explained, and one of these gratings was employed to converge sound by diffraction to a well-defined focus, and to exhibit around this alternate rings of noise and silence.

The lecturer concluded by describing experiments which he had lately made on the sensitive flame as a means of research,

the account of which had been already sent to the *American Journal of Science* for publication.

The lecture was profusely illustrated with both lantern and experiments, and awakened unusual interest.

A unanimous vote of thanks was given to PROF. STEVENS at the close.

March 11, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Fifty persons present.

After preliminary business of slight importance, DR. J. S. NEWBERRY presented the paper of the evening, entitled

THE MAN OF SPY, OR NEWLY DISCOVERED PALÆOLITHIC SKELETONS FROM THE VICINITY OF LIÈGE, BELGIUM.

(Abstract.)

After some general remarks upon the subject of the antiquity of man, and the interest and importance attaching to the topic, a description was given, illustrated with lantern views, of the remarkable discovery of early human remains in a cavern at Spy, near the city of Liège. These remains are regarded as the most important obtained since the discovery of the celebrated Neanderthal skull, many years ago; and some of the most eminent palæanthropologists consider them as presenting a recognizably pithecoid type, probably of the same race as the crania of Neanderthal and Canstadt.

The circumstances under which the skeletons of the men of Spy were found are briefly as follows:—

About eighteen miles from Liège, near Onoz Station, on the side of a wooded mountain composed of carboniferous limestone, a cave had long been known to exist. It consisted of a number of rooms connected by narrow passages, and some flint implements and other prehistoric relics had been taken from it. In 1885, the Count de Beauffort, to whom the property belonged, authorized two gentlemen of Liège, Messrs. De Puydt and Lohest, to make excavations there. The results proved to be of special interest, and were communicated to the public through a preliminary report published by the above-named gentlemen

at Namur, entitled "L'Homme Contemporain du Mammouth a Spy," consisting of thirty-one pages of text with ten lithographic plates; also in a more elaborate memoir published in the *Archives de Biologie*, Tome VII., 1886, by Julien Fraipont and Max Lohest, both officers of the University of Liège. Through the courtesy of M. Lohest, both these reports have been presented to the speaker. [These were exhibited at the Academy, together with lantern views of the crania and skeletons which formed the subject of the memoirs, and of which he had been permitted to make a personal examination.]

The excavations of Messrs. Du Puydt and Lohest were confined to the outer chamber of the cave and the terrace at its entrance. The bottom of the cavern was occupied by a sheet of made earth, from three to twelve feet in thickness, and above this a mass of fragments of the roof, which had fallen during the long interval since the occupation of the cave by prehistoric man. When the limestone fragments were removed, the sheet of made earth was found to include three layers, which contained bones and implements of different ages. The upper one contained some wrought flints, with a few bones of deer, mammoth, and bear. The bones had been intentionally broken, and the flesh which once covered them had been used for food. This layer was from two to three feet in thickness, of a yellow color, very calcareous, and sometimes passed into stalagmite. Only the upper part of this bed contained relics, which had evidently been left by the last occupants of the cave.

The second ossiferous layer was from two to twelve inches in thickness, was red in color, and contained in great abundance flint implements, fragments of bone, and wrought and ornamented objects of ivory. The animals represented in the collection from this layer are the woolly rhinoceros, the horse, the hog, the stag, the Irish elk, the reindeer, the sheep, two species of ox, the mammoth, the cave-bear, the badger, the fox, the wolf, the martin, the cave-hyena, and the cave-lion. The flint implements are all of rude form and evidently belonged to the Palæolithic age; the wrought objects in ivory are very numerous, and some of them are decorated with incised lines making a kind of herring-bone figure and evidently designed for ornament. There are also beads, earrings, pendants, etc., wrought with considerable skill and intended only for ornament.

The third layer was yellow in color, contained angular fragments of limestone, had a thickness varying from a few inches to a metre, and rested on the rocky bottom of the cave. This layer contained a few rudely chipped flint implements, the bones of the following animals: the woolly rhinoceros (*Rhinoceros tichorhinus*), the horse, the stag, the reindeer, the ox (*Bos pri-*

migenius), the mammoth, the cave-hyena, the cave-bear, and the badger; also two nearly complete human skeletons, which form the special subjects of the two memoirs. Of these skeletons, one was much dismembered and the cranium broken into about forty pieces. The second skeleton was much better preserved; it was resting on its right side, with the hand under the lower jaw; probably both were buried entire, and the subsequent injuries received were due to the fall of heavy masses of rock. The anatomical features of these skulls and skeletons are such as unite them with the other remains of the most ancient human race known,—that of Neanderthal, Canstadt, etc., of which they form by far the most complete and interesting representatives. The stature of these men was low, but they were very robust; the crania of good capacity, but having the forehead much depressed; the posterior portion of the skull expanded; the femur curved; the tibia *not* flattened, and the arm as short relatively as in any men of the present day. Among living races, the Eskimos and the Finns are most like the men of Spy, and may prove to be their descendants.

The detailed examination of these Belgian remains, presented in the full report of MM. Fraipont and Lohest, sets forth the view that with a skull and body entirely human in character there are combined a number of anatomical features resembling those of the anthropoid apes,—the assemblage being more marked than in any human race yet known. These features are mainly,—a powerful development of the superciliary ridges and the frontal sinus; a low, retreating forehead; a large occipital prominence; a small development of the chin; a marked prognathous tendency, with a central elevation of the row of teeth, beginning at the canines; a curvature of both arm and leg; a small-sized tibia; and the general bearing of the form when in the erect position.

The authors conclude by saying:—"In comparing the race of Neanderthal with those that appeared successively after it,—the race of Cro-Magnon, those of Furfooz, of the Neolithic period, and of the present,—we observe that the pithecoid features have more and more diminished, and have one after another disappeared. Some of them may still be found among the lowest races, or may reappear by atavism among European individuals. It may be that single features of this kind could even now recur, more markedly than in the man of Spy; but so large a number of pithecoid characters could not be found unless in the most ancient race of human beings yet known. Moreover, we believe that we have shown that the Chelléan man, the predecessor of those of Neanderthal and Spy,—who led a wandering life under the open sky, who chipped the amygdaloidal flints,

and lived at the time of *Elephas antiquus* and *Rhinoceros Merckii*,—is unknown to us as regards his ethnic character; as are also the manufacturers of the stone implements in the pliocene of Monte-aperto, and in the upper miocene of Italy and the Tagus valley in Portugal, and of the lower miocene of Thenay and Puy-Conray in France.

"If the most ancient ethnic type known to us could assume modifications during the Quaternary sufficient to give rise to races so different as those of Cro-Magnon and Furfooz,—losing so many inferior features and acquiring higher ones in their stead, . . . —there is no difficulty in conceiving that pliocene man was lower in type than the man of Spy. . . . The distance between this last type and the modern anthropoid apes is certainly enormous; it is less between the same man (of Spy) and the Dryopithecus (middle miocene of Saint-Gaudens). . . . But the ethnic type of lower Quaternary man had to advance a long way in order to assume the character of the present races, if indeed he was their ancestor."

These views will not pass without challenge; yet the results of the authors' careful measurements are well deserving of attention. It is worth while to remember that the Neanderthal skull, when first discovered, was regarded as even more pithecoid than these Belgian crania are now described to be; and much caution is needed in generalizing from such evidence. In regard to the Engis skull, another celebrated relic of the same age, classed with that of Neanderthal, Prof. Huxley goes so far as to say that it might have belonged to a philosopher.[1]

In view of such facts and such wide differences of opinion, it is well to wait somewhat before adopting the views of the Belgian scholars about the man of Spy. Both in the Old World and the New, skulls are known which, if found under circumstances indicating high antiquity, would be classed with these early Quaternary types. Another point to be noted is the fact that photographic representations of crania appear lower than geometrical (orthogonal) projections, and thus tend to exaggerate the peculiarities that are so much dwelt upon. [A camera-lucida outline by Huxley and a geometrical projection by

[1] The first impressions regarding these early skulls have been strikingly modified by later researches. Darwin called the Neanderthal skull well developed and capacious, though at first it was claimed to be so very degraded in type. Without going so far as this, Virchow and others have shown that crania of similar character are not so rare either in ancient or even modern times, in that part of Europe, particularly in Friesland; and other anthropologists have asserted that they had noticed heads of similar general type among people in various countries of Europe.

Lanzert, of the Neanderthal skull, were here shown, illustrating the difference thus produced in the effect.]

Whatever the result of the discussion, however, there is no question that this latest discovery adds a most interesting and important contribution to our knowledge of the early inhabitants of Europe.

March 18, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-seven persons present.

The paper of the evening, largely illustrated with maps, sections, and specimens, was read by MR. JOHN H. FURMAN, of King's Mountain, N. C., upon

THE TIN DEPOSITS OF NORTH CAROLINA.

The subject of discussion this evening has been announced as the tin deposits of North Carolina; at the same time I think it proper to remark that, while we call this the tin formation of North Carolina, it is also found to extend from South Carolina through North Carolina into Virginia, and that neither the northeastern nor the southwestern extremity of it has yet been determined.

The discovery of tin-ore was made in 1883 or 1884,—I am not certain which,—in the village of King's Mountain, N. C., by a young man named Claywell, a lad at the time, who was attending the school taught by Captain W. T. R. Bell, then of that place. He found loose pieces of cassiterite lying upon the surface, and was attracted by its peculiar appearance and unusual weight. He was not able to determine what it was, and placed it in his collection. This was sent on to Boston during an exhibition. Prof. Dabney was there at that time, and the specimen was marked "unknown." Some one saw it and had it analyzed, when it proved to be exceedingly rich in tin, the stone yielding about fifty per cent. As soon as this fact was made known, considerable excitement arose, resulting in the bonding of a good deal of property adjoining King's Mountain, and also in many projects for mining. All these proved futile, there being no further discovery until, in 1886, I visited King's Mountain and spent ten days in examining the deposits of the vicinity. The

result was that I discovered the lodes of "greisen" which have proved to be the matrix of the tin of that region, and which are found to occur there in a body of micaceous slate about one mile in width, extending from the granite on the west across to the limestone formation on the east.

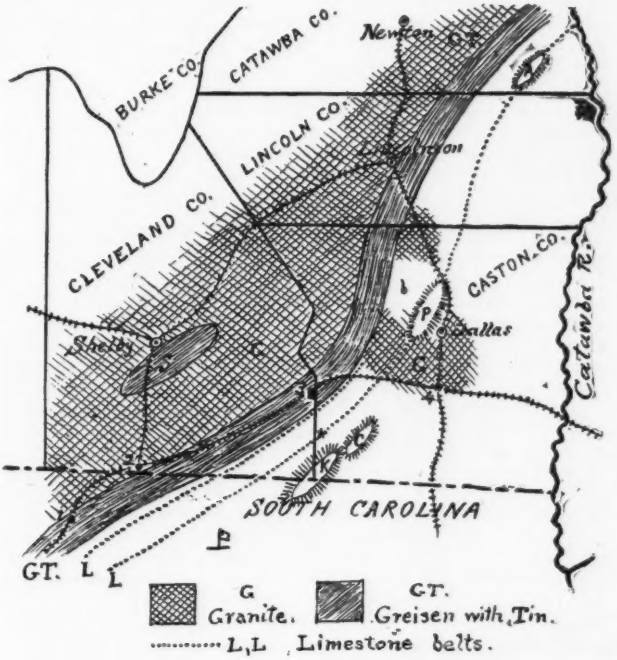


FIG. 1.—Map of the tin-bearing formation of North and South Carolina.

A, Anderson Mt.; *P*, Pasour Mt.; *K*, King's Mt.; *C*, Crowder's Mt.
1, Black's Station, S. C.; 2, Grover Station, N. C.; 3, King's Mt. Station; 4, Gastonia. The flag marks the locality of the old battlefield.

On the map (Fig. 1) the belt marked *G T* is only intended to represent the mica-slate area in which lodes of greisen with tin occur. This formation extends from near Black's Station in

South Carolina on through the North Carolina counties of Cleveland, Gaston, Lincoln, Catawba, etc., into Virginia, about Cumberland County. Nearly opposite King's Mountain, it is bounded on the west by granite, and on the east by the limestone formation, as I term it, which consists of two beds of limestone (*L, L*), imbedded in altered clay slates and other strata hereafter mentioned. The region of mica slates, *G T*, is not wholly composed of that rock, for in some places it seems to graduate into talcose schist; but the greisen in all instances continues.

Fig. 2, Plate II., is a cross-section from the east side of King's Mountain, the tallest peak representing its summit, through to the granite, northwesterly,—a distance of about five miles. In crossing eastward from the granite, we first come, on the left, to the mica-schist region; the black lines in it represent the veins or bodies of greisen, while a horizontal cross-lining represents the trap dikes. In traversing this tin formation it becomes apparent that there are two true fissure veins, and possibly others also. Crossing the trap dike, we come to the limestone formation, which is marked first by a vein or ledge of quartzite or altered sandstone, extending along its entire length in nearly a northeast and southwest direction. The dip of the different strata appears on the drawing nearly vertical; in reality it is about twenty degrees from the vertical, dipping to the west. Then, in making this cross-section, we come next to clay slates, then to limestone, then sandstone or quartzite again, then slates, then quartzite, then a trap dike, then slates, and so on until we come to a body of iron-ore which extends parallel with the limestone; then we have quartzite again and slates, and next an immense body of what I call "mountain slate," which has been termed talcose slate, carrying specular iron-ore—the gray ore that has been mentioned by Tuomey and Lieber in their accounts. Continuing, we come to more slates, then to an immense body of quartzites, and again to slates; and then we reach the centre of elevation of the region, the summit of King's Mountain, which is composed of the same altered sandstone or quartzite which I have mentioned; then we come again to the schists, and finally to a body of iron-ore, similar to the former one, of specular iron, which occurs in the same kind of mountain slate, or talcose schist, previously referred to.

It is evident that these strata were once nearly horizontal, perhaps entirely so, with the exception of the trap dikes and veins. During continental emergence, there was a folding and crumpling of the surface, which resulted in giving us the tilted beds as they are found to-day. Undoubtedly, during that period of disturbance, erosion almost incomprehensible must have

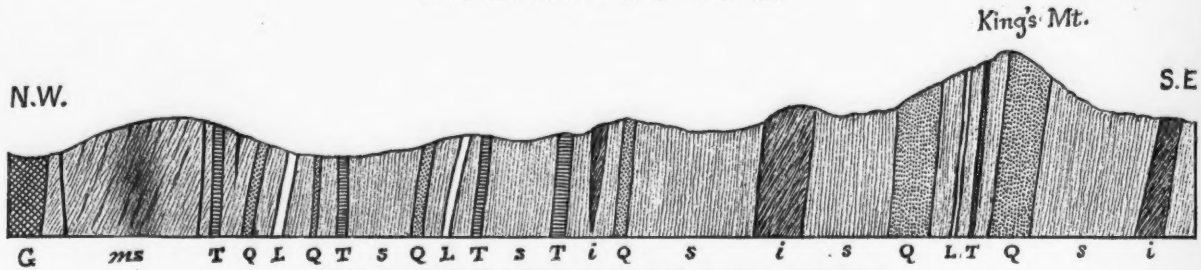


FIG. 2.—Section from King's Mountain to the granite, about five miles north-west.

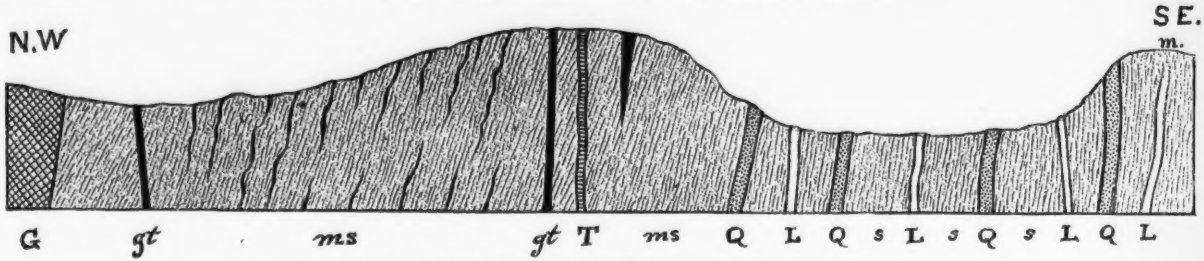


FIG. 3.—Section from the limestone of the old gold-mine, two miles to the granite.

G, granite; *T*, trap; *Q*, quartzite; *L*, limestone; *ms*, mica-slate, with greisen veins; *gt*, in black; *s*, altered slates; *i*, iron ore; *m*, position of old gold-mine.

taken place. I have been entirely unable to determine where the anticlinal axis is, since for many miles east of the summit I have found the same dip. I had supposed, in crossing King's Mountain, that probably the strata would be found dipping to the east; but upon examination I find that such is not the case. At any rate, we have here an illustration of the fact that erosion has taken place at some time on a vast scale, perhaps when the sands of the Tertiary formation were deposited, but certainly at a period exceedingly ancient.

Following this came another period of metamorphism, represented by the trap dikes found in that region. These dikes evidently did not make their appearance until the beds had been tilted, and the slates had assumed very much the same position occupied by them to-day.

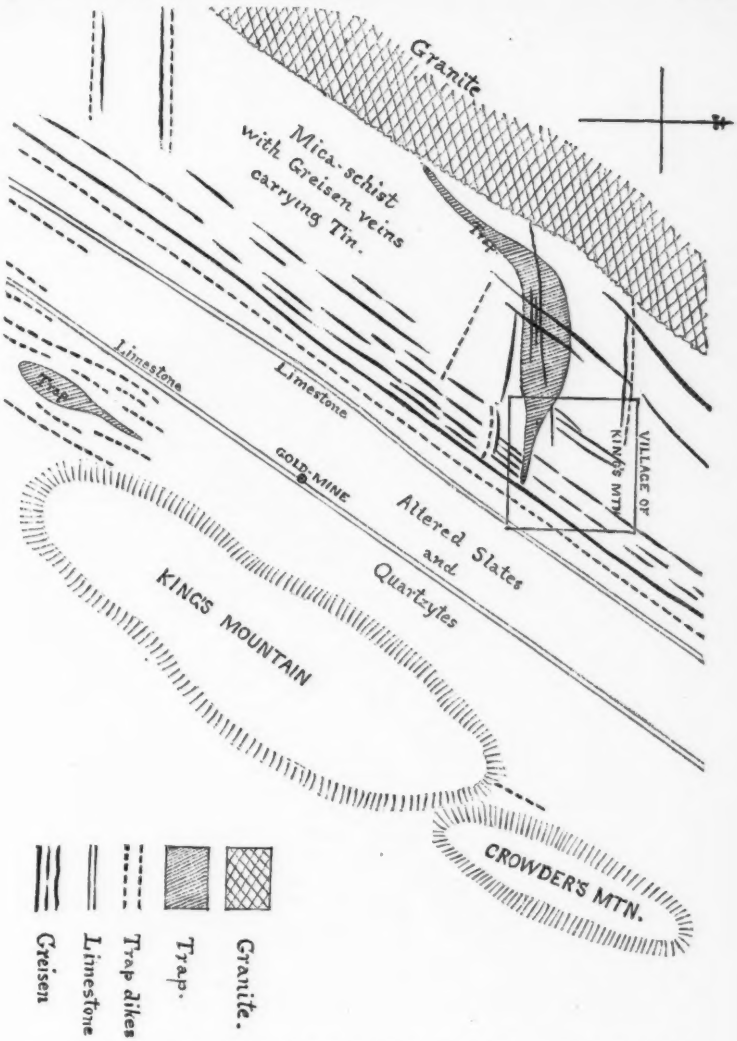
Subsequent to the period represented by the trap dikes, is the time when vein-making took place, and the mineral deposits of the region, both gold and tin, were formed. There are many evidences, to my mind, which go to prove this. In the first place, the trap dikes are doubtless later than the great period of uplift. In the second place, these greisen veins carrying tin are seen to be subsequent to the trap period, because, as is illustrated here on the map, Plate III., the veins of greisen are found cutting through the trap from the slates, running both northeast and southwest, and also nearly east and west, through the trap formation, which becomes for a short distance the country-rock, and appears there to be a diorite very much mingled with quartz. I have here samples showing exactly the rock of these greisen veins which cut the trap, and then the character which the dike assumes where it turns along the course of the granite boundary and becomes narrower.

Fig. 3, Plate II., is a cross-section (ideal) from the granite to the limestone. The limestone stratum shown farthest east marks the position, at *m*, of the King's Mountain gold-mine,—one of the oldest gold-mines in North Carolina, having been worked at different times for some fifty years. Between the granite and the sandstone or quartzite which marks the micaceous slates, I have placed one vein of greisen that is a true fissure, and also another similar one, and these two are the only unquestionable fissures that I have been able to discover. In all other instances, these deposits of greisen appear to conform to the mica-schists in which they are included, and to dip with them. In crossing this section of the country, while only two beds of limestone are apparent, it seems probable, from certain shales (ancient silt) which make their appearance on the surface, that other veins or strata of limestone will be found below. These shales have exactly the appearance of the black Silurian shales

that are found in the Devonian and also in the coal formations, resembling those bituminous schists in the Cumberland mountains which have caused attempts to find coal there outside of the coal measures. Wherever there is a stratum of limestone, a line of this shale is found; and the workings of the King's Mountain gold-mine have been to me one of the means for resolving some of the doubts respecting this subject. The mine occurs in connection with the eastern bed of limestone. This stratum of limestone is found in many places to be altered to quartzite, as though the lime had been dissolved and silica had been deposited in its place. Whenever such a change has occurred, the vein or ledge has been found correspondingly rich in gold.

In connection with this limestone stratum are found what have been termed by the miners "brown ore deposits." Imbedded in this brown ore are fragments of limestone which have the appearance of water-worn boulders; and in some instances metallic deposits, such as gray copper, galena, chalcopyrite, and iron pyrites, are found associated together, partially coating the water-worn fragments of limestone, and reminding one of the Bassick mine in Colorado. This fact would indicate that the entire deposition of metallic matter is due to the action of water. These brown ores do not represent the oxidation of iron pyrites proper. In connection with this stratum of limestone is a remarkable stream of water, which at this day has probably ceased to deposit mineral matter, unless perhaps in a very small degree. But in times past, that, or some other streams of which it is a representative, must have had much to do with the deposition of metallic matter.

It would appear that after the limestone had assumed its present position,—after it had been tilted, after the great period of disturbance, folding, and erosion,—there had been a subsequent disturbance. Of course it is difficult to determine this question; but from finding the fragments of limestone, in some places very large boulders, in these fissures occupied by this so-called brown ore,—which is a mixture, the base being silica and carrying free gold, very rich in places,—it would seem that the water acting as a solvent (perhaps at that period of time the water may have been heated, coming from depths below) filled the gashes and partial fissures by aqueous deposition after the limestone had been tilted; and again subsequent to that tilting there appears to have been further disturbance. I think so, because these fissures that are filled with brown ore must have occurred at that period subsequent to the tilting of the limestone. This brown ore does not stop at water-level. In that particular mine, they are now taking it out from 200 feet deep, while the water-level



Map of the vicinity of King's Mountain, N. C., to show the geological position of the tin-deposits.

is about 60 feet from the surface. Therefore it appears that the brown ore is not due to oxidation *per se*, but has been deposited by water. Such being the case, referring again to the tin-ore veins, I think that they are subsequent to the formation of the trap dikes, perhaps marking the exhaustion of that era,—that is, the era of which the trap dikes are representative. Not that I think the trap dikes themselves have anything to do with mineralizing the veins, but that they represent a period of metamorphism subsequent to the great foldings and their attendant period of erosion.

The map, Plate III., represents the topography of the country immediately at King's Mountain.

The square represents the village of that name. Next to the mountains we have the limestone stratum in which the old gold-mine is situated. West of it we have the limestone stratum which next to the quartzites bounds the tin formation. Then we cross the tin formation to the granite, with the same large body of trap before referred to, intersected by two sets of greisen veins; and the long, broken line represents the trap dike, which I have traced for a distance of fifty miles.

There is an interesting point in connection with this limestone ledge of the King's Mountain mine. I have not read Mr. Lieber's work, but I understand that he mentions the same fact, namely, that the draining of King's Mountain mine drains this limestone stratum, an iron-mine several miles to the southwest becoming dry whenever water is taken from the gold-mine. On the other hand, when the King's Mountain mine is allowed to fill with water and is no longer pumped out, then the water is found to fill that iron-mine.

In following the tin formation, I have found, from near Black's Station to within about three miles of Lincolnton, the cassiterite continuous in the greisen veins, which the greisen rock on the table fairly represents, although that is richer in tin than a great many. Therefore, from near Black's Station to near Lincolnton, a distance of about twenty-eight miles, these veins of greisen are found, in all instances, to carry cassiterite. Along this entire line on map No. 1, which represents the tin (I have omitted the trap dike), to a point about three miles in an air-line to the northeast of King's Mountain, the limestone continues to bound the tin formation on the east. Then we come to a region where we cross from granite to granite, similar in character on both sides of the tin formation. When I first made this discovery, I naturally supposed that the limestone formation had been cut off entirely. I traversed the granite for some distance both across and lineally, and, finding it to continue, I supposed that it extended to the

east unbroken, but further research proved the fact that the King's Mountain Range, with its sandstone and limestone, also passes through this granite formation further east than I first looked. Reaching the point left blank on this map (*b*), I found a district so completely covered with sand that it is impossible to determine what is the formation underneath. But going on further, we come to another body of granite, which makes me suppose it possible for this tin formation to be bounded on both sides with granite for a distance of eight or ten miles. Beyond this to the northeast, the altered slates and limestone formation assume precisely the same relative position to the tin formation which we find at King's Mountain. Beyond Lincolnton we no longer have this granite extending, but we find a region that has a very old appearance; the rocks are gneiss and well stratified, presenting the appearance of thick, coarse flagging-stones,—a section where magnetite is found in beds. The

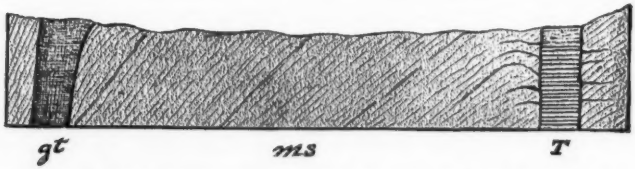


FIG. 5.—Section in railroad-cut near King's Mt. village; length shown, about 100 feet. *T*, trap-dike; *ms*, mica-slate; *gt*, large fissure-vein of greisen with tin.

rocks of Pasour, King's, and Anderson's Mountains are identical. In the tin formation of the country northeast of Lincolnton, I have only been able now and then to find cassiterite. In the first place, outcrops of greisen are meagre, and when found I have detected the presence of cassiterite in but one or two instances only.

Figure 5 represents the side of a railroad cut about half a mile from the village of King's Mountain, where the trap dike is shown distinctly cutting mica slates, which have here a direction of strike nearly northeast and southwest, the dike varying about fifteen degrees to the north. The fissure vein is found cutting the formation about ninety feet distant from the dike and parallel to it, and at that particular point has a transverse section which at first appears to be almost columnar across the fissure, resembling very much the dike itself; but a close examination reveals a division in the rocks which approaches in resemblance to a combed texture. Besides, we have on each

side a small vein of quartz. Following this fissure, it becomes a simple vein and again assumes distinctly a banded structure.

When we consider the extent of territory occupied by this tin formation, its great length, and the thickness of the veins, it is natural to conclude that somewhere along this line there should be deposits of value. Examining the entire field, I have become convinced, although it is possible to be mistaken, that from near Lincolnton, N. C., to about Black's Station, S. C., is that portion where valuable deposits are most likely to occur. The best part is probably from King's Mountain village, some two miles to the northeast, and five or six miles, possibly seven, to the southwest. My reason is this: In the first place, in and near the village of King's Mountain larger pieces of cassiterite have been found than anywhere else. Some pieces gathered on the surface have weighed as much as two pounds. Without any difficulty, one can pick up specimens of cassiterite anywhere from the village to a distance two miles northeast and about five miles southwest.

When we remember that these tin deposits, if I am correct, represent the youngest period of time there, viz., the vein-making period, following as it does that represented by the trap dikes, I think we may fairly suppose that the forces of nature were not severe in their action when the veins were forming. Therefore I doubt whether any very great amount of erosion has taken place since the tin veins were formed, and believe rather that the great period of erosion preceded the formation of those veins. Again, in regard to surface disintegration, the evidence is that since the tin veins were formed there has been comparatively very little of it. The decomposition or surface change apparent is mostly in place to-day,—*i.e.*, it has not been eroded and carried off. This is conclusively proved by beds of kaolin in place, and by veins of quartz also, in the clay which was slate. Both Lyell and Agassiz note precisely the same occurrence. Again, the forests with their carpetings must be remembered as a protection.

I think that these tin veins are due also to the action of water; that is, that water was the great agent in their deposition. It would seem that in getting nearer the surface or to the top of the slates, which become firmer and more crystalline as depth is attained, there was greater room for expansion, and that the capping of the veins found greater room for deposition near the surface of the formation, whereas deeper down they were confined entirely between the walls.

Again, when we take into account the fact that greisen lodes occur in the trap, and that we find a distinct fissure, filled with greisen, cutting the trap formation in two, it appears to me that

the theory which I think was first advanced by your worthy President, of vein-making due to the aqueous agency in a great measure, is without doubt illustrated.

We go back now to the King's Mountain gold-mine, and we find, at certain depths, changes in the metallic contents of the lode or vein,—for what reason I am unable to say, because it might appear, by the water action, that the contents of the lode should be similar from the surface down, yet we find, as we reach greater depths, that a change takes place. Copper appears and there is some promise of its occurring in larger quantities; other minerals also are making their appearance. On examining the tin formation, we find now and then, along the surface, evidences that the slates carry some iron pyrites, but the greisen rock shows very little of it near the surface; as depth is reached, however, we find cassiterite associated to some extent with iron pyrites. This pyrites near the surface appears to be fine, as though it had been dusted into the rock and mostly between the laminæ of the slate; but deeper it assumes a crystalline structure and becomes cubical. When again we note the fact that, as we go deeper into this tin formation, chalcopyrite also makes its appearance, I have come to the following conclusion. It may be only an idea; but as men accustomed to study these matters, and to do some little mining, generally form conclusions from appearances,—conclusions in some instances not warranted, but in other instances proved to be true,—so I have come to believe that cassiterite will be found in increasing quantities in depth to an extent that will prove it to be of great value, *in certain parts of the veins.* In England, it is a well-known fact that where they commenced to mine for copper, deeper work resulted in tin, and at greater depths copper again, and at still greater depths cassiterite. That would at least tend somewhat to prove that there are zones of minerals. And while there is no arbitrary law to prove that tin will occur in greater quantity with depth, still, when we consider the fact that it is a crystalline mineral, eminently so, I think that as we go deeper, where the rock becomes more crystalline, mica-schists grow harder and small veins of quartz make their appearance,—bedded veins of quartz, two or three inches in thickness, *which do not show on the surface and which carry small quantities of cassiterite,*—the argument to me is in favor of its increasing in quantity as greater depth is attained.

The specimen of greisen on the table is the representative rock of the tin formation. I have adopted Mr. Dana's definition of greisen, who calls it a quartzose rock or one belonging to the quartz family, because I find it on the one hand graduating to the true granite, and on the other hand absolutely to a crystal-

line quartz. This variety of rock has been found to be richer in cassiterite than those which carry less mica and more nearly approach quartz or feldspar in composition.

My intention this evening was merely to deliver an informal talk upon this subject, to show the veins of tin-ore and the region in which it is found, and to give a few crude ideas on the subject that may lead to further investigation by those who are more capable and more familiar with geology and mineralogy than myself.

Respecting map No. 1, I would remark that we have not the true course of the tin formation; the curve was rendered necessary by the unfortunate way of putting places on the maps. This formation runs nearly due northeast and southwest until it crosses the granite, and then it turns due north and south until the granite region is passed, when it takes again nearly the northeast and southwest course, which continues to be the trend as far as I have examined it.

The Richmond and Danville Railroad, after leaving Danville, crosses this micaceous formation with the identical trap leads, the greisen rock, etc., though the greisen differs somewhat in appearance from that near King's Mountain, the mica appearing to be more on the order of muscovite, and the feldspar looks dryer, though the general appearance of the rock is similar. This formation crosses the railroad between Danville and Lynchburg, commencing about thirteen miles from Franklin Station and extending three miles north of it, in a width, *as the railroad runs*, of about sixteen miles, embracing the King's Mountain formation, precisely the same rock, accompanied by the mica slates, etc. Whether the limestone occurs there or not, I am not now informed.

Respecting the trap dikes, my observations have led me to conclude that they are identical with those of New Jersey and belong to the same period.

DISCUSSION.

DR. ALBERT R. LEDOUX.—I think that the first thing necessary to say is something that our friend MR. FURMAN touched upon so very lightly that it may not perhaps have been noticed. This is, that to MR. FURMAN himself belongs the credit, not only of the discussion, not only of the examination of this deposit, but we may say of the discovery of it; because, although it is true that a school-boy some years ago picked up a piece of cassiterite, MR. FURMAN was the first to discover the tin in the

rock, and in the region which I hope will be the first in America to produce tin upon a commercial scale.

In the discussion, for which I find myself named upon the card this evening, I shall "fight very shy" in regard to the geological aspects. But there are one or two points which, as a chemist, have attracted my attention in visiting the locality and in reading of it. Then there is another point at which all Americans arrive sooner or later,—the question of the probability, or the possibility, of the enterprise paying.

After looking over recently the report of Dr. Carpenter, of the Dakota School of Mines, in which he groups together the discussions and papers and varied experiences of the last ten years regarding the Dakota tin deposits of which we have heard so much, I have been impressed by the fact that MR. FURMAN'S statements to-night are almost identical with those that are made about the Dakota deposits,—so much so that by reading a few extracts from Dr. Carpenter's report it will be seen that what he says of Dakota is applicable to North Carolina; and perhaps the theory that Dr. Carpenter adduces here will be valuable in this connection.

[DR. LEDOUX here read several passages from the report referred to, quoted in part from Profs. N. H. Winchell, Wm. P. Blake, and the late Prof. Henry Newton.]

Dr. Carpenter hitherto has been giving very largely the opinions of those who preceded him, but in the latter part of the book, where he puts forth his own ideas, it appears that there also they agree with MR. FURMAN'S account.

The first discovery of tin in the Black Hills was due to an accident, as it was in North Carolina.

I have read these extracts, although they apply to Dakota, and I think if I had said nothing about Dakota and had been describing the North Carolina deposits, they would have been equally true.

There is one point that bears upon the question of the commercial value of those veins, and that is the fact that we know to exist, that wherever tin has been worked in veins, the world over, it has also been worked with more or less success, usually more, in the gravels. And the same description which I have read

here, and which is true of the North Carolina deposits, applies equally well to the tin deposits of Australia, where the greisen is like this; and it is true also that these Australian deposits, where they have been worked with comparatively little success in the veins, have yielded profit in the gravels.

MR. FURMAN has given no figures; and although I have made many analyses both of small samples and of samples weighing as much as fifty tons, yet, as one would naturally expect, in any deposit where the material sought for is scattered all through the rock, very little result can be reached by assays, so I am not prepared to present any figures that would give anything like an average of these veins. On the one hand, there are bodies that have been exposed, perhaps a number of tons of mineral, that would yield up to five or six per cent of tin, but nothing like an average of such richness; and if one should estimate it at less than one per cent, he would probably be nearer the truth.

But, on the other hand, in that whole region, from King's Mountain several miles north and five or six miles south, wherever there is a stream, we find more or less stream-tin, and as we get down to the large creek which runs between the tin formation and the King's Mountain range proper, even there we find it. The question as to whether or not there has been sufficient surface decomposition of the rocks to render the stream-tin a paying enterprise, is a very important one. As I understand it, it is not believed that glacial action extended as far south as the Carolinas; and this being the case, the kind of erosion or decomposition is only that incidental to atmospheric action.

Now, in all the slates further northeast, in the gold-bearing sections, and from what one can see here in the railroad cuts, the soft soil extends very deep, and one can go down with a pick and shovel as far as sixty or seventy feet before reaching rock hard enough to blast; and where a railroad cut goes through, owing to the great variations of the winter temperature,—almost daily freezing and thawing,—the rock is very quickly decomposed; so that naturally, unless there were some abnormal conditions present, I would expect to find that these deposits had not been eroded there, but simply decomposed by the agencies of frost,

heat, rain, etc. We find places on that ridge where the soil is very thin, not averaging perhaps more than two or three feet; but everywhere below the centre of the ridge we find tin, sometimes in the streams; I have seen as much as eight or ten pounds of cassiterite from a miner's pan containing, say, twenty pounds of gravel; so that, in addition to echoing MR. FURMAN'S hope that somewhere in that region we shall find tin which will pay to mine, I hope we shall find it in more accessible forms than in tin-stone. It is remarkably cheap to work. In the vicinity of King's Mountain, there is hardly any winter at all; there is considerable rain, but it is rarely that snow lies forty-eight hours on the ground, or that there is any freezing-up, so as to compel mining operations to stop. We have been paying a dollar a cord for good fire-wood, delivered where it is wanted; and a fair miner's wages there are seventy-five cents to a dollar a day; so that every condition seems favorable, except the undemonstrated condition of finding sufficient ore to work.

MR. FURMAN stated,—in reply to a gentleman in the audience who asked the height of King's Mountain,—that the village is twelve hundred feet above the sea: the mountain proper is about two thousand feet.

THE PRESIDENT (DR. NEWBERRY).—The description of the tin deposits of North Carolina given by MR. FURMAN has interested me exceedingly, from the parallelism it shows between the structure of that region and that of the tin-bearing districts of the Black Hills and other portions of the world. Tin is a metal that is very sparsely distributed. The great masses brought from Tasmania, shown at the Centennial Exhibition, were quite phenomenal, and it is not at all surprising that we do not find it in such masses here. It is still an open question whether tin can be profitably worked in the Black Hills; the quantity is enormous, and yet it remains to be seen whether metal enough can be got out of each cubic yard of those great veins to pay the cost. Certainly the conditions in North Carolina seem to be much more favorable.

The tin that has come to us from various parts of the world has all been taken from surface deposits, except that of Cornwall; there it has been regularly mined as iron and gold are

mined; but all the tin brought from the island of Banca, from the Malay peninsula, and from Australia, is obtained by the working-over of gravel. The granite containing it has been largely carried away, and what remains is decomposed, so that the tin is obtained by washing. There, too, labor is very cheap. The Chinese do well at placer mining, where Americans would starve.

I do not know whether we can ascertain how large a quantity of material has been taken from King's Mountain by erosion; but further north in the Alleghanies the rocks have been very largely removed. Where erosion has been less active, the rock has been rotted down to a depth of thirty to sixty feet, just as Prof. Agassiz tells us that in Brazil the rocks are sometimes decomposed to the depth of 150 feet. If any such decay has affected the tin-bearing rocks of North Carolina, the ore could be cheaply worked-out, if sufficient water were to be had.

I think we owe a great debt to MR. FURMAN for his discovery, and for the very lucid description he has given us. That it is a true tin deposit there can be no question, but just how much it will be worth to us *is* a question.

This is a very different affair from the so-called tin-stone that was brought here from Virginia three or four years ago. A hundred pounds of it were sent to me, and we had it analyzed in the School of Mines, but never got any tin from it. Other parties have claimed that they found in it 20 per cent of the metal. I have seen certificates from those who profess to be assayers, claiming large returns of tin from this rock. I do not believe that there is any tin in it at all. But this is a real tin deposit, and it may be that it will prove a productive one. I would like to ask about the water there.

DR. LEDOUX.—There is plenty of water in the creek 100 feet below, that being the water-shed where the vein is.

THE PRESIDENT.—The lack of water may be a difficulty. I should like it if we could get there a head of 500 feet of water, as they do in California, where they cut down gravel banks 100 feet high and make a handsome profit from gravel, of which a cubic yard will yield but ten cents.

In this connection, I have to show you a very different style

of tin-ore which comes from Zacatecas, Mexico. One of our old students, Mr. Banks, has just come back from there, bringing many specimens and having examined a considerable territory. In that region there is some stream-tin, but not like that found elsewhere. Generally it occurs in drops and knobs, with a fibrous internal structure, and the masses are of concretionary character. This is different; for it is distributed irregularly through a rhyolite rock that has been evidently very much digested with hot water. The quantity is often large, and yet there, as elsewhere, it is a problem whether there is any deposit that can be worked with profit. I think the general impression has been that it would not pay to do regular mining there. Probably the only way to obtain tin profitably is to employ the natives to wash it out, working the deposit as a placer.

Tin is not nearly so rare a material as it has been said to be. Lumps of cassiterite are often found in the gold-gravels of Idaho, and there are veins of tin-ore in the Temescal mine near Los Angeles, Cal.; but Mr. Stokes spent a year there, and, after fairly testing the deposit, he came to the conclusion that it would not pay to work it. So we are not so very destitute of tin in North America, but the conditions for the profitable mining of it are peculiar. It must be where, if possible, nature has decomposed the rock; then labor must be cheap, if we are to come in competition with the sources of supply in Tasmania and elsewhere. The conditions described to us by MR. FURMAN in North Carolina would appear to be favorable, and it seems as though the chances were better for working the deposits there than in other places.

In regard to the Black Hills, we have had a great variety of testimony. Mr. Bailey, who was one of the first heralds of the great deposit of tin there, has told his story in this room. He brought before the Academy a splendid series of specimens, and claimed that the deposits of tin from which they were taken were unparalleled; but, though that was several years ago, no tin has yet come to market from that region, even after the expenditure of much money and mining on a large scale. The attempt has not yet been a success there. This North Carolina deposit promises better than any I have known elsewhere in this

country; and yet I think it a matter of doubt whether the rock can be worked with profit. The mass before us is an unusually rich specimen of ore, and there is tin enough in it to pay for crushing and washing; but a great deal of that sort of work is often done by nature; almost all gold-mining depends for its success upon decomposition of the rock. The gold-bearing rock has been made ready for the hand of the washer by natural processes, otherwise it would not pay to work; and the same is generally true of tin.

THE PRESIDENT called upon MR. WILLIAM E. DODGE, expressing his pleasure at that gentleman's presence, and desiring him to make further remarks upon the subject, as one with which he was familiar from extended experience in the commercial value and production of metals.

MR. DODGE, in reply, expressed great interest in the facts as presented by MR. FURMAN, but stated that he did not feel sufficient familiarity with the local conditions to add anything to the discussion at present.

March 25, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Sixty-five persons present.

The fourth Public Lecture of the season's course was delivered by the REV. E. C. BOLLES, of New York, upon

THE LITTLE BUILDERS OF THE EARTH,

and was largely illustrated with lantern views.

April 1, 1889.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-four persons present.

The report of the Council was read, recommending the payment of certain small bills, and a few other items of minor importance.

THE PRESIDENT announced to the Academy the death of PROFESSOR FREDERICK STENGEL, long an active resident member and a frequent attendant at the meetings. He made a brief address referring to the varied learning and accomplishments of PROF. STENGEL, especially in the department of modern languages and literature, and to the great urbanity and friendship which characterized his social relations.

PROF. D. S. MARTIN read by title the following papers, published in the ANNALS, Vol. IV., No. 12, and Vol. V., No. 1, respectively:

(1) THE CALCEOCRINIDÆ, A REVISION OF THE FAMILY, WITH DESCRIPTIONS OF NEW SPECIES;

BY EUGENE N. S. RINGUEBERG.

(2) A CATALOGUE OF NORTH AMERICAN PALÆOZOIC CRUSTACEA, BELONGING TO NON-TRILOBITIC GENERA;

BY ANTHONY W. VOGDES.

PROF. MARTIN called the attention of the members to the very beautiful and remarkable collection of the gems and gem-yielding minerals of the United States, now to be seen for a few days at the establishment of Messrs. Tiffany & Co., prior to its being sent to Europe as a part of their exhibit at the Paris Exposition. This collection had been gathered and arranged for this purpose by one of the Academy's own members, Mr. GEORGE F. KUNZ; and it gives, even to one somewhat familiar with American mineralogy, a surprising illustration of the richness of our country in the gem-yielding species. He referred to several of the most remarkable of these specimens, instancing particularly the large and splendid aquamarine beryls from

Stoneham, Maine, and the elegant series of light-colored spessartine garnets from Virginia, together with other rare and interesting gems.

PROF. DAVID P. TODD, of Amherst College, then read the paper announced for the evening, entitled

RESULTS OF OBSERVATIONS ON THE TOTAL SOLAR ECLIPSE OF JANUARY 1ST, 1889.

(Abstract.)

The clear skies nearly everywhere prevalent within the belt of total eclipse in California, and the large number of astronomers and others in the field, contribute to make this one of the most important eclipses ever observed.

(1) *Eye-Observations.*

Several hundred drawings of the solar corona were made, partly in response to instructions sent out by the National Academy, and partly to the Lick Observatory. The former I have embodied in a paper *On Composite Coronagraphy*, presented to the National Academy. Many drew the corona adjacent to the sun's poles with a telescope; while others, following the instructions, and setting up an opaque disc about 50 feet from the eye, and large enough to shield the eye from the blinding radiance of the inner corona, sketched the very faint outlying streamers along the ecliptic to a distance of several millions of miles. The results of all this work were photographically incorporated into the composite. The extreme outer equatorial corona is very weak in actinic effect, quite different from the inner corona; and it is very doubtful if it has ever been photographed. Eye-observations are therefore very valuable. Speaking of the corona as a whole, it was larger, brighter, and more irregular than usual. It resembled quite strongly the corona of 1868 as drawn by Bullock, and that of 1878 as shown by the photographs in the Naval Observatory report. Thus the periodicity in figure, particularly in the outer corona, first suggested by Ranyard, appears to be verified.

The shadow-bands were excessively faint, narrow, and close together. Prof. Upton endeavored to photograph them on a white screen, but with only indifferent results. Fourteen replies to his circular requesting observations of them, report their velocity variously; but the general direction of their motion was from northeast to southwest before totality. Their faintness or entire absence in California may be taken as evidence in favor of the

theory that they are atmospheric phenomena mainly; as the atmosphere in that region is steadier, and the phenomena of irregular refraction would not be so pronounced. In Montana and Manitoba, the bands were well seen, and described by some as *visible wind.*

Meteorological observations proper were made by Prof. Payne and Prof. Upton, the latter making the fall in temperature greatest ten minutes after totality, when it amounted to 5°. The barometric fluctuation attributable to the eclipse was practically zero. The humidity rose 30 per cent. There was no dew, but papers were perceptibly dampened. The velocity of the wind died down, but increased after totality. There was a slight veering to the west near totality, due perhaps to change of vapor conditions in the upper air. It is now sufficiently demonstrated that the barometer need not be observed in future eclipses.

(2) *Telescopic Observations.*

Contact-observations were made in abundance, and will serve for the very accurate calculation of the position of the moon's centre. Prof. Swift's search for intra-mercurian planets was frustrated by clouds.

Photographic methods had not heretofore sufficed to show the detail of the polar streamers of the corona; and the telescope was used by many, with much success, in detailed sketching of these filaments. They are not radial from the sun's centre, but from areas about the sun's poles. For the most part they are straight, and give the impression of shooting out from the sun as if it were a disc and not a sphere. Brashear sketched these very neatly on a sheet of ground glass, with a faint light behind it to illumine it slightly. Black and white being reversed, the glass could be used like an ordinary negative in printing.

(3) *Cameras and Photographic Telescopes.*

These were used by the score, and of great variety. The most important work was that of the Pacific Coast Amateur Photographers' Association, which secured 167 plates with great variations of exposure, sensitive plates, and photographic apparatus. Mr. Burckhalter used a 10½-inch Brashear reflector, obtaining excellent pictures of the corona. Prof. Pritchett was provided with one of the 6-inch Dallmeyer portrait-lenses belonging to the Naval Observatory, and his negatives show a fine outer corona. Mr. Barnard, with a 3-inch telescope, secured one of the best photographs of the corona ever taken.

The Harvard party, in charge of Mr. Pickering, had 14 tele-

scopes and cameras; a 5-inch telescope was used for a study of the brightness of the inner corona and the protuberances; the 8-inch Boyden telescope on the outer corona; and with the 13-inch Boyden photographic telescope, the largest ever used in an eclipse, 8 plates were taken, with varying exposures, to show every part of the corona in its proper relation. These negatives show the moon $1\frac{7}{8}$ inches in diameter. With the 8-inch Bache telescope were taken 6 negatives to show the outer corona and possible intra-mercurian planets.

With the 40-foot photoheliograph at the Lick Observatory, where the eclipse was not quite total, twelve views of the partial eclipse were taken between clouds.

(4) *Spectroscopes.*

In the main, the spectroscopic work was done by the Harvard party, and was wholly photographic. Eight spectroscopes were used. The new reversing-layer spectroscope, specially devised for this eclipse, was brought into service 10 seconds before, and continued till 30 seconds after, totality. Also a quadruplex spectroscope was used to give spectra of different tracts of the corona simultaneously. Plates stained with erythrosin carried the spectrum low down in the red, while quartz lenses and prisms were used for the ultra-violet. Of the preliminary spectroscopic results Mr. Pickering writes: "Three good spectra were secured, showing all the lines present between F and L. If there were any other lines present in that region, they must have presented so little contrast to the background of continuous spectrum that the present photographic plates would be unable to show them. The spectrum was very simple, however, showing only 4 or 5 lines besides those of hydrogen. Solar spectra were taken prior to the eclipse, which will enable us to identify the position of all the lines. I have one curious spectrum taken on an erythrosin plate, with a line which I have not as yet identified, but which I think will probably show the 1,474 line."

Mr. Barnard employed a common form of prismatic camera for the coronal rings and protuberances, and Mr. Keeler, also of the Lick Observatory party, repeated Hastings' observation with the double prism. Mr. Keeler's preliminary conclusions are that "a coronal spectrum-line cannot always be an index of the height to which the corresponding gas extends in the corona itself; and that the behavior of the 1,474 line (and others) at the two limbs of the sun does not seem to justify the belief that the corona is chiefly, or in any great degree, a diffraction phenomenon."

(5) *Polariscopes* (not used).

(6) *Photometers.*

Several results were secured by the Amateur Photographers' Association. Mr. Leuschner made 7 measures of the total light of the corona with a modified form of wheel- or disc-photometer. The Harvard party used a quadruplex photographic telescope, with perforated tin plates having several hundred apertures, and a measure can be made of the intensity of the coronal light which has passed through each aperture. Twenty-five negatives were obtained on dry plates which had been accurately standardized by Mr. Pickering at the Harvard Observatory.

April 8, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Sixty-four persons present.

The meeting was held in the Geological Lecture-room of the School of Mines building, for convenience in displaying and examining the specimens described in the first communication.

DR. NEWBERRY then gave the paper of the evening, upon

AMBER: ITS HISTORY, OCCURRENCE, AND USE.

(Abstract.)

He began by referring to a very large and rich collection of specimens of amber, illustrating all the varieties found in the amber district of North Germany, which had recently been sent to the School of Mines as a present by one of its earliest graduates, MR. H. A. DEMELLI, for some years past a resident of Berlin. This gentleman had enjoyed unusual opportunities for obtaining rare and choice specimens of amber, and had made this remarkable collection as an expression of interest in the institution where he had studied in former years, and sent it over in a very elegant case of inlaid work, etc.—itself a beautiful work of art.

[The cabinet and its contents were exhibited to the members in the adjoining Museum-room. A great variety of rough ambers, of all shades and qualities, were displayed on the upper shelves; and below, a remarkable collection of cut and polished specimens, containing insects and leaves.]

Amber had become an object of interest and admiration at a very early period. Its great beauty, its easy working, and its curious electrical properties, have made it a favorite material for ornaments and charms among many peoples and in almost every age. The Baltic shore of Germany and Poland, and the low region adjacent to those coasts, have been the great source of supply from prehistoric time till now, although some had been obtained from other localities. But the Baltic amber is distinguished by its golden color, while that of Sicily and the French coast near Marseilles is more red in hue. The Baltic amber can be recognized in ancient tombs, etc., not only widely over Europe, but as far as the banks of the Indus. Beautiful necklaces, etc., composed of it are found in Etruscan graves of remote antiquity, although the lustre and transparency have long since been destroyed by oxidation or some similar chemical change due to centuries of burial. It evidently formed one of the most important articles of prehistoric trade and transportation.

The amber of the Baltic region is generally regarded as having exuded from the tree named, for that reason, *Pinus succinifer*. Coniferous wood is, indeed, found in association with the fossil resin, and there is little doubt that this was the tree that yielded it. But absolute evidence on this point is still lacking. In Japan, the case is different. An amber is there found so intermingled with the wood and leaves of a fossil species of *Sequoia* as to leave no room for uncertainty regarding its parent tree. In many other localities, also, small amounts of amber or closely-related resins occur included in lignite and brown coals.

Many other points were touched upon as to different varieties of amber and the estimation in which they are held for ornamental uses, other kindred resins, the inclusion of leaves, insects, etc., and the interest attaching to specimens so delicate and so perfectly preserved.

Dr. N. L. Britton remarked upon the occasional occurrence of amber in New Jersey, in connection with the lignites so abundant in the Cretaceous and Eocene beds.

Prof. D. S. Martin said that the acquisition of so large and rich a collection of this interesting and beautiful material, with its included insects, etc., is a matter for congratulation to all lovers of science in the city, and its presence here in a fire-proof building, where it is both accessible and secure, is highly gratifying.

He made some observations on the peculiar surfaces presented

by these fossil resins when exhumed, particularly referring to that of copal. He had examined and collected many specimens bearing on the illustration of these external surfaces, and was convinced that they are all due to contraction of the resin during long burial and hardening. In copal, it is quite possible to trace the transition from evident contraction-cracks, by a gradually increasing complexity of intersections, to the stellate or so-called "goose-skin" marking, so characteristic of the fine grades of that resin.

Further remarks were made by several members regarding the cutting of amber, etc.

MR. GEORGE F. KUNZ spoke upon American ambers, and exhibited specimens of several, especially one of great beauty recently brought from Mexico.

For the last fifteen or twenty years, travellers have occasionally brought specimens of a very remarkable amber from some locality in Southern Mexico. The only information gained concerning it is that it is brought to the coast by the natives, who say that it occurs in the interior so plentifully and in such large pieces as to be used by them for making fires. The color of this amber is a rich, deep golden-yellow, and when viewed in different positions it exhibits a remarkable green fluorescence, similar to that of uranine or of certain petroleums. [A specimen was exhibited, belonging to Mr. M. T. Lynde, and measuring 4x3x2 inches.] It is perfectly transparent, and is even more beautiful than the famous so-called opalescent or green amber found at Catania, Sicily.

This material would be extremely valuable for use in the arts. It is believed that an expedition has started for the locality where it is found in the interior.

Mr. Kunz also gave the following notes on certain interesting minerals:—

Through the kindness of a friend in India, the specimens of tabasheer which I exhibit (opalescent silicious masses found in the joints of the bamboo) were obtained at the Calcutta Fair, in November, 1888. This substance, though mentioned in all text-books, is very rarely seen here, and invites especial attention, since it exhibits all the interesting properties shown in the

hydrophane described by me before the Academy of Sciences several years ago, absorbing almost an equal bulk of water, and then becoming transparent. Oculus Beli and Oculus Mundi were names applied to a substance brought from the East several centuries ago, which probably was this same tabasheer. These specimens are of peculiar interest, since we have here a substance of organic origin, not to be distinguished from one of which the origin is purely mineral. The color is opaque white, but it becomes entirely transparent on immersion in a colorless liquid.

The specimen of fire-opal exhibited this evening, evidently a water-worn fragment, was found near John Davis River, in Crook County, Oregon. It is transparent, grayish-white in color, with red, green, and yellow flames. The play of colors equals in beauty that of any Mexican material, and it is the first opal found in the United States that exhibits color. Undoubtedly, better material of the kind exists where this was found.

During the last year large quantities of gadolinite were sent from near Bluffton, in Llano County, Texas, twenty-two miles from Burnett. The occurrence of this gadolinite was somewhat similar to that of allanite in Amherst County, Virginia; it has more than ordinary interest from the fact that it contains from forty to fifty per cent of yttria. About one thousand pounds were found in a single pocket, associated, it is stated, with xenotime, fergusonite, and euxenite. One crystal was exhibited weighing eleven pounds; another was found weighing thirteen pounds, and a group weighing forty pounds. The productions of this locality exceed in quantity and size anything yet obtained.

During the summer of 1888, a small diamond, weighing about half a carat, was found by Mr. C. O. Helm on the farm of Henry Burris, about three hundred yards from Cabin Fork Creek, Russell County, near Adair County, Kentucky. While walking through an old field, on the top of a hill, Mr. Helm observed in the gravel this small, bright stone, which on investigation proved to be a diamond, octahedral in form, with curved faces, lustrous, but slightly off-color. The rock in the vicinity is said to be composed of granite dikes, slates, and some "float-

ing" rocks,—such as quartz, feldspar, magnetic iron ore, flint, garnets, etc.,—mingled in clayey hills.

He then gave a brief account of the collection of gems and gem-minerals of the United States, prepared for the coming Exposition at Paris, as a part of the exhibit of Messrs. Tiffany & Co., of this city, and referred to by Prof. Martin at the last meeting of the Academy.

The catalogue, now in preparation, will contain nearly four hundred entries, many of them including several specimens, under the general title of "Precious and Ornamental Stones of North America."

First comes a series of native golds from California, Colorado, New Mexico, and North Carolina,—crystallized, wire-gold, in quartz, etc.,—and native silvers from Lake Superior. Among the former is a portion of the first-discovered placer gold from Sutter's Mill, California,—found by John Marshall, July 19th and 20th, 1849,—and a specimen of the gold in turquoise from Los Cerillos, N. M.

Next is a group of gold and silver ornaments obtained from Indian mounds in Orange and Sumter Counties, Florida.

North American diamonds are represented by four small crystals from California, and one from Kentucky (that just described from Cabin Fork Creek), and by models of others from North Carolina, Georgia, and Virginia, the latter being the largest (over twenty-three carats) found in this country, and known as the "Dewey" diamond, 1855.

A large set of corundum specimens, chiefly from North Carolina,—ruby, sapphire, green, brown, asteriated, etc.,—both cut and uncut, is shown.

Very fine topazes are displayed, of rich wine-yellow, from Cheyenne Mountain, Colorado, and some white ones from other points.

The North Carolina emeralds are naturally conspicuous, though more striking as crystals, for their size, color, and mineralogical interest, than as transparent gems for jewelry. But the beryls from Maine and Connecticut, and from the snow-line locality on Mt. Antero, Colorado, have yielded cut specimens of

surpassing beauty (aquamarines), especially the large gems from Stoneham, Maine.

Garnets are represented in great variety and from numerous localities. One almandite crystal from Salida, Colorado, weighs fourteen pounds; it is well-formed but opaque. As gems, the most remarkable are the dark ruby-like pyropes, from Navajo Reservation, N. M., and the elegant spessartites, hyacinth-red, from Amelia C. H., Virginia.

Tourmaline is also largely displayed, in almost all its varieties, particularly the richly-colored specimens from Auburn and Paris, Maine. The mingling of red, white, and green in some of the crystal-sections is very fine, as are also the cut stones of all these tints, besides lavender and indigo.

The new and wholly American gem Hiddenite ("lithia emerald"), a variety of spodumene from North Carolina, is of course included. Peridote appears also, some of the stones being cut from the olivine inclusions in the meteorite of Carroll County, Kentucky.

Quartz is represented by nearly a hundred entries in the catalogue. As gems, of course the first place belongs to the amethysts, of which there are many splendid crystallized specimens, and a number of cut stones of unsurpassed color and lustre. The latter are chiefly from Maine, Pennsylvania, and North Carolina. Hyaline quartz, citrine, smoky quartz (some of the latter making beautiful cut gems), rose-quartz, etc., represent the glassy varieties; while agates, chalcedonies, semi-opals, etc., are abundantly shown. The Oregon precious opal, just described, is among those here displayed.

Quartz inclusions come next, and are a markedly interesting feature. The rutilated specimens from North Carolina and Vermont are especially noteworthy. Byssolite, and hornblende, penetrating quartz, and forming the "Thetis' hair-stone" of Rhode Island, and stibnite similarly penetrating, from Nevada, may be mentioned; but the most remarkable specimens are probably three from Yuma County, Arizona, in which the rare mineral Dumortierite (which occurs also on New York Island) has so thickly penetrated and so deeply colored a matrix of quartz as to present the appearance of fine blue lapis-lazuli.

The feldspars appear in several of their choice varieties,—amazon-stone, moonstone, peristerite, etc., and in their amorphous forms, as porphyry and obsidian. The use of all these materials for ornamental work is well illustrated, and indicates the possibility of much more extended application. The same remark applies to a number of other species of minerals which we are not in the habit of associating with use in jewelry or the arts. Among these may be mentioned the following:

Wollastonite, diopside, scapolite, gadolinite, danburite, sodalite, pectolite, schorlomite, etc.

Two cut gems of canary-yellow willemite are worthy of particular mention.

The semi-precious stones, rhodonite, cyanite, chlorastrolite, and others, are of course represented. Very beautiful polished serpentines (Williamsite and Bowenite) are included; as also the cut and polished fossil corals from the Devonian limestones of Iowa.

Turquoise, from the New Mexican mines at Los Cerillos, is well represented, and possesses interest from the great value attached to it by the aboriginal races. This is doubtless the precious green stone so prized by the Aztecs under the name of chalchihuitl. Several of the specimens in this collection are native Indian work,—beads, charms, etc.

Here may be mentioned a number of arrow-heads of obsidian, agate, chalcedony, silicified wood, hyaline quartz, citrine, etc., which show much taste in the selection of choice material, as well as delicate skill of execution, to have been possessed by the Indian tribes.

Amber is represented by several specimens, among which the most striking is the Mexican piece previously described, with its green fluorescence.

The last feature in the collection is the illustration of North American pearls and pearl-yielding shellfish. Green pearls and nacreous concretions from *Haliotis* ("abalone") shells, of the coast of Lower California, and pink pearls from the West Indian conch (*Strombus gigas*), together with the clam and oyster pearls, black or white, of our own neighboring shore, are included; but the chief display of pearls proper is from the fresh-

water bivalves of our rivers and lakes. Shells and pearls of *Unio, Anodon, Margaritana,* etc., of many species and varied tints, are here brought together, and form a very interesting exhibit of the yield of these beautiful objects by the "river mussels" so abundant in the United States.

April 15, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Fifty persons present.

The fifth lecture of the Public Course was delivered, upon

GLACIAL MORAINES IN THE FRONT RANGE, COLORADO,

by MR. FREDERICK H. CHAPIN, of Hartford, Conn.

[Illustrated with an extensive series of lantern views taken by the lecturer during his travels among the mountains referred to.]

DR. NEWBERRY added some remarks in regard to the eroding power of ice, as shown in the great moraines observed by him in British America.

A unanimous vote of thanks was tendered to MR. CHAPIN.

April 22, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-one persons present.

DR. J. J. FRIEDRICH exhibited a number of specimens from the shell-mounds of Cedar Keys, Florida, consisting chiefly of shells. He had been unable to find a trace of implements, un-

less a piece broken apparently from the lip of a large conch, and of uncertain use, could be so regarded. This mound was found to be very extensive; and he would estimate the time required for its construction as perhaps four hundred years,—supposing the population of the islet to have amounted to two thousand. Some of the shells of which it is composed are still abundant on the coast, while others are now rarer, and one species at least has undoubtedly become extinct.

Dr. Newberry said that he also had examined this mound, when on a visit to Florida some years previous. He observed a large live-oak tree growing upon it, indicating of course that a long period had elapsed since the mound had been abandoned and ceased to receive additions. Dr. Friedrich's computation of four hundred years, for the time taken to form the mound, was a minimum period. It was probably much longer, as the population of the islet could scarcely have been at any time so large as two thousand. He had succeeded in finding a human skull in the mound, and part of a skeleton.

Mr. John C. Henderson read the paper announced for the evening, entitled

THE TEHUANTEPEC SHIP RAILWAY.

Conterminous for fourteen hundred or more miles with the southern border of the United States, lies the Republic of Mexico, —a country with an area about sixteen times that of the great State of New York.

South of Mexico for about twelve hundred miles, extends a beautiful and fertile region, whose width varies from about three hundred to about twenty-eight miles. This picturesque land may be viewed as a great causeway, uniting North and South America, and dividing, in the middle of the American continent, the waters of the Atlantic Ocean from the Pacific main. Its superb scenery is diversified by a chain of mountains extending almost its entire length and having peaks which rise from three thousand to fourteen thousand feet above the waters of the oceans. From a geographical point of view, the great isthmus which unites the two Americas should be considered as embracing a part of Mexico and as being about fourteen or fifteen hundred miles in length. Its area is about three hundred thousand square miles,—an area out of which six States of the size of New York could be formed. This isthmus is a vast natural bridge,—

destined to be of priceless value to the people of America,—over which a great railway is some time to be built, which will unite the railway systems of North and South America. Happily, without altering its character as a bridge uniting the northern and southern continents, interoceanic highways for ships can be built across it.

The part of the American isthmus which belongs to Mexico is called Tehuantepec. In the year 1847, the President of the United States offered to make with Mexico a treaty by which our Government would pay fifteen millions of dollars for Tehuantepec. Fifteen millions of dollars, at that time, represented to the Government of the United States a vastly greater sum than it does at the present day. But a far-sighted statesmanship justly recognized this as a geographical position of great value to the people of North America.

After expensive surveys, it was discovered that however great would be the distance saved by vessels of the United States engaged in coastwise and foreign trade, could they be borne across the northern part of the American isthmus instead of having to make an immense detour of the entire continent,—or to sail many hundreds of miles southwardly to enable them to cross the isthmus at Panama or at Nicaragua,—a ship canal at Tehuantepec would have to be constructed over an elevation of between seven and eight hundred feet above the sea, and would require between one and two hundred locks,—in short, that its construction might be justly considered as almost or quite impracticable. But the late Captain James B. Eads raised the question whether science is not equal to devising a better means of transit for ocean vessels across the American isthmus than the best of canal navigation could afford.

One peculiarity believed by many travellers to characterize the oriental nations, is that the people, for generation after generation, use only the same mechanical contrivances that were employed by their fathers. For many hundreds of years canals have been used as highways for commerce in different parts of the world; and these were found, for certain purposes, an improvement upon roads. The famous canals of China have done much to bind together many of its widely separated sections of country, and long before America was discovered by Columbus they might well have filled Europeans with admiration. Many people may be surprised to hear that the freight-boats which are constantly plying upon the rivers and artificial water-courses of China, are so great in number, and her inland commerce of such stupendous dimensions, that it has been said to have a greater amount of tonnage than all the other nations of the earth combined. The canal-system of China, however, is in various respects

far from perfect, and a railroad system would be an invaluable blessing to the Chinese Empire. But probably vast numbers of Chinese would listen with incredulity should they be told of railways which accomplish for commerce far more than canals,—indeed, of railroad cars in America upon which Chinese canal-boats could be borne with wondrous speed over immense distances.

James B. Eads, one of the most distinguished engineers of his age, devised a railway over which the largest ships in the world are to be transported across the American isthmus at Tehuantepec. The railway is to have what may be called heavy rails of fine steel. The number of rails may be four, or six, or even eight, according to the size of the ship to be transported. At each end of the ship-railway, vessels are to be conducted into a basin which will open into what may be called a dry-dock, such as is used in raising out of the water the largest ships. As a vessel is raised out of the water, it finds itself on a great car which was waiting at the bottom of the dry-dock to receive it—a great car on wheels and on a railroad. By mechanical contrivances based on very interesting scientific principles, the ship is laid in its cradle as gently, one may almost be permitted to say, as a mother lays her babe upon its little bed. The railway car is to have a large number—some hundreds—of wheels, and is to be so admirably constructed of steel that it will possess very great strength. The ship when on the car is, by what may well be called a masterpiece of ingenuity, to rest on supports which will so adjust themselves to it that the vessel will be practically as truly water-borne as though it rested on a lake, the weight of the vessel being equally distributed over the entire car. The car, which is to be several hundred feet long, can be lengthened or shortened according to the size of the vessel which it is to transport. The car-wheels are to be two feet in diameter, and are to be placed three feet apart on the six or more rails on which the ship car is to run. The question may be raised, "Would not a loaded ship,—which would weigh far more heavily in its centre than at its bow or stern,—when placed on a car, be of such enormous weight that the ground would yield under the crushing pressure which the rails would be called upon to bear?" Eads, when dealing with such a question, showed that a vessel upon the ship-car would have its weight, by the agency of its cradle and the construction of the car, so equalized and distributed over a large surface that no one of the wheels of the car will have to bear a weight greater than five tons, although each of them would be capable of sustaining twenty tons. Over each wheel will be placed a steel spring capable of bearing twenty tons before closing,—a

spring which will make each wheel bear its fair proportion of weight, should it pass over any ordinary inequality in the rails.

The ship-railway is to have practically no curves. By means of great deflecting-tables the direction of the ship-car whenever necessary is to be turned. The lay of the ground at Tehuantepec is very happily suited for such a great railroad. The ship can be borne across the isthmus at the rate of about eight or ten miles an hour or more. Ships using this railway would not only travel across the isthmus much faster than they could by means of a canal, but they would in various respects be safer on the railroad car. A vessel passing through a canal has to move very slowly; it is always in danger of being injured by going a little too close to the side of the canal, and may even at times ground under very unpleasant circumstances.

There are various reasons why a ship-railway located at Tehuantepec will be of great value to the commerce of the United States. It will be within a few hundred miles of the city of Mexico. It can easily be united to the railroad system of North America. Its commercial relations with the United States and Mexico will necessarily be peculiarly intimate. Eads planned to make a very fine harbor for Tehuantepec, which would become an entrepôt for a vast commerce with Mexico, and where vessels could readily be supplied with an abundance of coal from the United States.

To appreciate even faintly the value of a ship-railway at this point, one needs to glance at a map of the American continent and then to extend his view to the map of the world. The American continent is the greatest in length of any continent on the globe. A vessel going from New York to San Francisco cannot sail around the northern part of America, through the icy regions of the Arctic Ocean; while to go around its cold and stormy southern extremity, at Cape Horn, necessitates the sailing of 14,200 nautical miles,—a nautical mile being about one-sixth greater in length than is a statute mile. A ship-railway at Tehuantepec would shorten this distance by 9,800 miles, making the voyage but 4,400 miles.

One might here pause and consider how inestimably important to nations is commerce—how it affects the comfort, the wealth, the intellectual tone, and the manners of a people. It is a means of binding together in happy relations widely separated countries. Many an humble workman living in the city of New York has upon his breakfast-table tea which has been transported nineteen or more thousand miles from China, sugar which was obtained from sugar-cane which grew in Cuba or in India, and fruits that were raised in climates suited to their growth. Perhaps the bread which he eats was made of wheat raised on

the western coast of the United States and has been transported in ships by a long, dangerous voyage around Cape Horn,—the "Cape of Storms," as it has been called.

To say that a people have little commerce is to say that they are devoid of many of the decencies and comforts—and of some of the greatest blessings—of modern civilization. Well may statesmen endeavor to promote the best interests of a people by duly caring for their commercial development.

The Government of the United States has spent, in one form and another, a large amount of money in surveys for a suitable place for a passage across the American isthmus. A practicable route for an interoceanic canal, with locks, at Panama was surveyed by officers of our Government during the administration of President Grant. Had De Lesseps adopted that route, there would have been a canal to-day at Panama. It has been found by surveys that an interoceanic canal could be built at Nicaragua. Gen. Grant refused an offer, made to him by De Lesseps, of fifty or sixty thousand dollars a year to act as President of the Panama Canal Company; but he would gladly,—indeed, it was a noble ambition of his to do so,—have become the President of an interoceanic canal at Nicaragua. The building of such a canal at Nicaragua has much in some respects to commend it to American citizens; but grave doubts were entertained by Captain Eads,—one of the highest of authorities on such a subject,—whether it would be practicable to make a suitable harbor at the eastern terminus of the canal. In his opinion, a ship-railway at Tehuantepec would be far better for the people of the United States,—owing to important political as well as commercial reasons,—than would be even an American interoceanic canal at Nicaragua.

As the American isthmus is about 1,500 miles in length, it must make an important difference to the people of North America,—and indeed to no inconsiderable degree to England,—whether a gateway for ships across the isthmus is opened at its northern or at its southern part. A vessel going from New York to San Francisco would save about 1,173 miles by going by way of Tehuantepec instead of by way of Panama. On every round trip it would save 2,346 miles.

A large number of the vessels of the United States are propelled by sails. A sailing-vessel going from any American port, and using the ship-railway at Tehuantepec, would enjoy the great advantage of being borne onwards on its journey by friendly trade-winds. To a less extent it would also have this advantage if it went by way of the splendid Lake of Nicaragua. But there is a region of calms in the Caribbean Sea and on the Pacific Ocean off the coast of Panama. Vessels crossing the isthmus

there would have to go through these calms. The mariner who attempts to cross this region in a sailing-vessel, is, as a rule, subjected to heart-sickening detention. His vessel is apt to lie for day after day and week after week,—and sometimes for month after month,—listlessly on the glassy waters. If the sails fill with wind, and his heart begins to beat with joy, he is very apt to find that only a momentary breeze has swept by, or that a squall ushering in a tropical shower threatens his vessel with destruction. When the sun shines, it does so with a heat so scorching as to injure in various ways the vessel and to make the sailors prematurely old. As the sailor finds that day after day he makes scarcely any progress, he is apt to feel that he would far rather face the storms, and sail 10,000 miles to round Cape Horn, than have his life wasted in a region of calms. But few sailing-vessels would probably attempt a second time to go from New York to the Pacific Ocean by way of Panama. Skilful navigators might indeed get through the region of calms in but one or two weeks' longer time than it would usually take for them to go by way of Nicaragua,—that is, if they knew just how to keep on the borders of the region of calms, or just what course at all times to take; —but on every round trip a sailing-vessel, under the most favorable circumstances that it could expect, would lose much time. Tehuantepec is several hundred miles further north of Nicaragua than is Nicaragua north of Panama. Vessels crossing the isthmus by way of Tehuantepec would often have a breeze when vessels going by way of Nicaragua would meet with no friendly wind. If two sailing-vessels should start from New York or from New Orleans, for almost any port of Asia or Australia, one of them going by way of Tehuantepec and the other by way of Panama, as a rule the one going by way of Tehuantepec would be thousands of miles on its journey,—perhaps at the Sandwich Islands, if its course lay in their direction,—while the other would be lingering in the region of calms.

While a wooden sailing-vessel is lying becalmed off the coast of Panama it is attacked beneath its water-line by what are called ship-worms. The species of ship-worm known as the *Teredo navalis* is now to be found probably in every sea. These creatures did such injury to the piles which were used on the great dikes that protect Holland from the ocean,—dikes which have cost not less than $1,500,000,—that the Dutch Government has at times appealed to science to deliver them from their attacks. These ship-worms, when very young, attack wooden vessels that are not covered with copper sheathing, or in some such way protected from them. The holes by which they enter the sides of a ship are no larger than pins' heads, but when they have once entered the wood they grow rapidly. They line their bores with

a kind of shelly deposit, and they bore onward as they increase in size. The ordinary *Teredo navalis* does not grow to be very large, but in the waters off the coasts of the American isthmus ship-worms become sometimes ten inches or even much more in length. Many a gallant vessel has been obliged to succumb to these creatures, the hull becoming honeycombed with the holes which they have bored. It has been supposed that if ships could go suddenly from salt water into fresh water, or lie at anchor in a large fresh-water lake,—such as Lake Nicaragua,—they would be delivered from these pests; but the dreaded *Teredo* has been found in brackish water, and one distinguished naturalist has claimed that it has been found alive even in fresh water. But could a vessel be taken out of the water,—as when it is being transported across the isthmus of Tehuantepec,—it is almost certain that the ship-worms would quickly die, as they are so sensitive to air that they never attack piers or vessels above the water-line.

Another foe to ships,—of iron as well as of wood,—is the little crustacean shell-fish commonly known as the barnacle. These fasten themselves in such numbers on a vessel that its speed becomes much affected. Fast steamers,—even the finest which sail the seas,—must be taken out of the water from time to time, to rid them of these pests. The barnacles, it is believed, could not live if a vessel could enter fresh water, or lie at anchor in a lake; but though the barnacles would die, their shells would be so cemented to the vessel that it would be needful for the hull to be taken out of the water and scraped. Eads, in planning his ship-railway, made provision for side-tracks upon which the ship-car can be run while the ship with which it is loaded is scraped and painted, and refitted in every way.

Tehuantepec is some six or seven hundred miles nearer to the United States by land than is Nicaragua. By looking at a map it can be seen that, while Panama and Nicaragua are bathed by the waters of the Caribbean Sea, Tehuantepec is washed by the waters of the almost land-inclosed Gulf of Mexico. This great American gulf is about one thousand miles in length by eight hundred in width, and receives the discharge of a vaster river system than is found on any other continent. Into it empties the Mississippi, which, with its forty-two navigable tributaries, waters in part twenty-one States and Territories. Fourteen of these are sometimes called "Mississippi Valley States." This vast, fair, and fertile region is capable of supporting hundreds of millions of people. Joined,—or to be joined,—with the Mississippi River by a canal, and possibly by a railway for vessels, are the great American lakes,—inland seas,—which have been estimated to contain about one-third of all the fresh water in

the world. As in some part of the Mississippi valley almost any climate can be found, the most varied products are always being borne in a very economical manner on its waters.

For a long time the Mississippi River was closed to large vessels, owing to a bar at its entrance. Captain Eads rendered his country an inestimable service by devising a method of making a permanent channel at the entrance of the Mississippi—a channel of sufficient size to admit the largest vessels used in commerce. Although thus, and in various ways, Eads had performed services of very great value already to his country, yet he further aspired to the practical opening, for the immense commerce borne on the waters of the Mississippi, by means of a ship railway at Tehuantepec, of a channel into the waters of the Pacific Ocean, which covers nearly two-fifths of the surface of the globe, and waters the shores of continents and islands where live six or seven hundred millions of people. By a map of the Gulf of Mexico it will be seen that Tehuantepec is opposite to the point where the Mississippi River enters the Gulf. A vessel, when it sails from San Francisco to the mouth of the Mississippi, and goes around Cape Horn, has to travel about 16,112 statute miles,—a much greater distance than it would have to go if it went to Asia or to Australia. Should it be transported across the isthmus at Panama, it would have to sail 5,418 miles, while at Tehuantepec it would need to travel only 3,561 miles,—a less distance by 1,857 miles. By this route it would save on every round trip a distance of 3,714 miles, as compared with Panama. When one reflects how large a commerce might be carried on between the mouth of the Mississippi River and the western coast of the United States, he may well feel that it is a matter of vast importance to our people that the place of transit across the isthmus should be at Tehuantepec rather than at Panama. It would be worth many millions of dollars yearly to the great coastwise trade of the United States to be enabled to cross the isthmus at the former point rather than the latter.

Eads, in planning a ship-railway to cross at Tehuantepec, had in view considerations of a military as well as of a commercial nature. During the great civil war in the United States, he had given much thought to some important military needs of his country. Three days after the flag had been fired upon at Fort Sumter, he had been summoned to Washington by a member of Mr. Lincoln's Cabinet to advise the Government respecting the wisest manner of utilizing for military purposes the Mississippi and other rivers. The great engineer himself at once built with wonderful despatch eight river gunboats. Shortly after presenting these formidable vessels to his Government, he had six more constructed, four of them being built in part on plans

which he himself devised. The military services which he was enabled to render his country were very great. With his trained eye, Eads saw that, should the United States become engaged in war with a European power, the latter might endeavor to do the United States great injury by seizing and using to its own advantage a ship-canal. He feared that it would be very difficult for our Government to protect against great hostile fleets an interoceanic canal at Panama or at Nicaragua. Such a canal could be very easily rendered useless for long periods in a time of war. A single torpedo would be enough to destroy a lock, and to let loose a flood of water which might greatly injure the canal. A single vessel intentionally sunk in a canal might make it impassable for a fleet of war-ships. Damage done to a ship-railway could be more quickly repaired. Eads had plans by which the Gulf of Mexico would be practically converted into an American lake. By defending its entrance he would defend Tehuantepec. He devised a plan for the defence of the ship-railway which would practically make it secure against attack by any fleet likely to attempt its capture. It was also to be in such close connection with the railway system of Mexico and of the United States, that large bodies of soldiers could be sent to its defence at very short notice.

On the eastern side, the approach to the ship-railway is to be for twenty-five miles by the beautiful Coatzacoalcos River. On the Pacific side, it will be through a large lagoon. The length of the railway was to be about one hundred and thirty-four miles.

Captain Eads had the pleasure of seeing his plans for a ship-railway at Tehuantepec approved by eminent engineers. Constructors-in-chief, alike of the British and of the American navy, as well as eminent builders of ships and of dry-docks in Great Britain, united in giving their indorsement in an official manner to the practicability of transporting ships across the American isthmus by means of Eads' ship-railway. A committee of the United States Senate, after listening to whatever objections the advocates of an interoceanic canal had to offer to Eads' plan, made a report on March 6th, 1882, in the course of which it was said: "The first question the committee considered was as to the practicability of constructing a railway for the purpose of transporting ships and their cargoes. The testimony before the committee conclusively demonstrates the fact that such a railway is entirely practicable, and that loaded vessels can be transported over the same with absolute safety and economy." In the course of this report, the committee, after quoting from testimony given by American engineers respecting the practicability of constructing a ship-railway, continued:

"The testimony on this subject is so overwhelming and conclusive in its character that the committee has no hesitation in reporting that the construction of a ship-railway and its successful operation are entirely practicable." The Senate committee, after quoting at considerable length from a very interesting report that a Congressional committee had already made on the subject,—a report which especially pointed out the immense advantages which the people of the United States would derive should the gateway across the isthmus be at Tehuantepec rather than at Nicaragua or Panama,—added the following statement: "The committee has considered the testimony taken before the House committee, and fully indorse the statement that Tehuantepec is the American route, and that the transit-way should by all means be located there in preference to any other point upon the isthmus."

In connection with the Senate report just quoted, it is interesting to observe that President Cleveland, in his Annual Message dated December 8th, 1885, alluding to Eads' ship-railway, somewhat incidentally said: "The Tehuantepec route is declared, by engineers of the highest repute and by competent scientists, to afford an entirely practicable transit for vessels and cargoes, by means of a ship-railway from the Atlantic to the Pacific." Such a statement, which had been made by a committee of Congress, must have been very gratifying to Eads.

Captain Eads wished the United States Government, as well as the Government of Mexico, to aid in the construction of the ship-railway by guaranteeing a limited amount of interest on the money spent in construction. This money, however, was to be but practically a loan. The Government of the United States was to receive in various ways very valuable concessions from the railway company. One important feature of Eads' project was that the United States Government was not to pay any money in aiding the ship-railway company, unless the latter should successfully carry out its contract to transport over the railway in a specified manner vessels of a given tonnage. Unless the ship-railway accomplished all that it agreed to do, it was to receive no aid from our Government.

It was not given to Eads to see his great project in active operation. Some of us, let us hope, will live to have that pleasure. Eads' ship-railway is designed to transport in a day a far larger number of vessels than can an interoceanic canal. It can be built much more rapidly than a canal. It can afford, it is believed, to transport vessels at less cost than is possible by canal navigation. If successful, it will be a means of greatly increasing the inducements to Americans to build ships, and will in various ways call into life many new industries. The people of

the United States would not wish to see it controlled by a foreign power. They would not wish to see it becoming a great monopoly, charging exorbitantly for transporting American vessels from ocean to ocean. Probably in no juster or better way could the Government of the United States have a voice in its management, than by duly aiding in its construction. It may be worth every year to the people of the United States far more than will be its entire cost,—even though that cost should be fifty or one hundred millions of dollars. It will pass over a country having, except near the Coatzacoalcos River, a very healthy climate. At either end of the ship-railway, a great commercial city may be expected to arise; and the Mexican Government is deeply interested in securing its construction. We may hope that it will soon be built.

Remarks on MR. HENDERSON'S paper were made by MR. ANDREWS, who sustained the views therein set forth.

April 29, 1889.

Owing to the celebration of the Centennial of Washington's Inauguration, during this and the following day, no meeting of the Academy was held on this evening.

May 6, 1889.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-three persons present.

The Report of the Council was read, and its several recommendations adopted, viz.:

(1) The election of the following gentlemen as Resident Members:—

ORLANDO B. POTTER.
EMORY MCCLINTOCK.

(2) The election of the following Resident Members as Fellows:

FRANZ BOAS; THOMAS L. CASEY; CHARLES A. DOREMUS; THOMAS A. EDISON; ALBERT R. LEDOUX; HENRY G. MARQUAND; H. J. NEWTON; LEWIS M. RUTHERFORD; ANTHONY W. VOGDES.

(3) The appropriation of the following amounts in payment of bills:

From the Publication Committee:

Issue of ANNALS and TRANSACTIONS to date	$217 35
Photo-engraving of plates for the same	28 00
Incidental expenses of the Committee for April, 1889	11 80

From the Librarian:

Binding of volumes and parts	$98 15
Incidental expenses	12 98

And to authorize expenditures as follows:

For additional binding of books	$100 00
For electrotype plates for TRANSACTIONS	18 00

In accordance with the directions of the Council,—

The Librarian, DR. N. L. BRITTON, exhibited the additions received to the Library since the last meeting, and read the full list of titles of the same.

He also announced an interesting discovery of a stone adze, found in an excavation at the Moravian Cemetery on Staten Island.

PROF. O. P. HUBBARD made some remarks upon the differences in durability of various building-stones, and noted particularly the permanence of some forms of slate, as shown in old graveyards, where slate headstones are very enduring, and retain their inscriptions for long periods.

DR. NEWBERRY continued the same topic, and spoke of the destructive effect upon marbles and limestones of sulphurous acid engendered in the combustion of bituminous coal, in cities where that material is used for fuel.

He then gave an outline of the most important work done at the meeting of the National Academy of Sciences, and at that of the Council of the American Geological Society, both held during the past week at Washington.

Among the most interesting papers was that of MR. C. D. WALCOTT on the "Revision and Arrangement of the Cambrian Rocks of North America," in which he literally reverses at an important point the conclusions heretofore received regarding our oldest fossiliferous rocks, by showing, on seemingly incontestable evidence, that the Paradoxides zone, which has always been regarded as the basal member of the American Cambrian, really overlies the Olenellus zone, heretofore placed as the second member. He finds in Newfoundland some well-defined sections where, for the first time, these lower Cambrian beds, hitherto known only separately at scattered points, are exposed in distinct and continuous superposition; and here the Olenellus series lies at the base, with the Paradoxides beds above it. This very interesting result would involve, of course, the transfer of the St. John's, or Acadian, group and the old conglomerates of Braintree, Mass., to a position later than the beds of Georgia, Vt., and of Troy and Schodack in this State, which latter would then take their place as the earliest fossiliferous strata of Eastern North America.

Mr. Walcott further correlates the Cambrian rocks of the coast region with those of the Far West, and presents a full and definite account of this great and interesting division of the geological series.

THE PRESIDENT also spoke of the presentation of his own completed studies on the Cretaceous Flora of North America, soon to appear as one of the volumes of the U. S. Geological Survey.

May 13, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Nineteen persons present.

The publications received during the week were enumerated and shown.

The following paper was read by title:—

A REVISION OF THE EDENTULOUS GENERA OF CURIMATINÆ.

BY CARL H. EIGENMANN AND R. S. EIGENMANN.

It is published in the ANNALS, Vol. IV., No. 12.

THE PRESIDENT remarked upon some choice and interesting minerals which had been sent him from Colorado, and exhibited specimens, particularly one of wulfenite, with crystals of extraordinary size and beauty.

The first paper assigned for the evening was then read, entitled

REMARKS ON RECENT DISCOVERIES IN LOCAL CRETACEOUS AND QUATERNARY GEOLOGY.

BY N. L. BRITTON.

The following notes have not been obtained in any systematic study of the strata involved. They have been made from time to time, and are offered now as only supplementary to former contributions.

CRETACEOUS.

Fossil-bearing Concretions in the Plastic Clay Series.

For a number of years, Mr. Hollick and myself have been noting with considerable interest and curiosity a great abundance of ferruginous clayey concretions on the shore of Raritan Bay, near the extreme southern end of Staten Island, at Tottenville. They occur scattered along the beach for half a mile or more, and are most abundant at the base of the high bluff just south of the old Billop House of Revolutionary fame. Here we have seen them weighing over a hundred pounds, and sometimes three feet in diameter and four inches or more in thickness. Mr. Hollick first noticed that certain of these concretions contained vegetable impressions, and described them in the Proceedings of the Natural Science Association of Staten Island, of December 8th, 1883, noting their similarity to those formerly obtained by Mr. Bailey Willis under quite similar conditions on the shore of Hempstead Bay, at Dosoris Island, near Glen Cove, L. I.[1] Since that time, a considerable number of specimens of leaves and fruits have been thus obtained, all of which have been

[1] See TRANSACTIONS of this Academy, VI., 16 (1886), and Merrill in ANNALS, III., 345 (1886).

drawn by Mr. Hollick, and most of the specimens deposited in the Museum of the Natural Science Association of Staten Island, at New Brighton. They will perhaps form the subject of a subsequent communication. Considerable additions to the collections of this material have recently been made, and the nodular concretions have been again observed on the shore at Prince's Bay, but those from this last-named locality have hitherto proved barren of fossils. Similar masses have been observed at Clifton, where one specimen containing a leaf-impression was obtained, and again near Pleasant Plains station.

While we have always supposed, from the occurrence of these masses, that they were of Cretaceous age, it is only very recently that evidence has been available which appears to be conclusive on this point. On May 1st, I went with Mr. Hollick along the north shore of the Raritan River, from Perth Amboy, for several miles. There are steep banks along this entire stretch, except where interrupted by areas of salt meadow which occupy ancient fiords, cut out by streams when the continent stood higher than it now does. At the base of these banks we noticed the concretions that we had become so familiar with on Staten Island, some of them containing vegetable remains. We soon found the concretions exactly in place in the Cretaceous brick-clays, which we had never been able to observe on Staten Island. Further than this, we collected specimens which contain numerous casts of Lamellibranch and Gasteropod mollusca evidently of Cretaceous types, but not yet submitted to Professor Whitfield for determination. These masses are closely similar to those from Staten Island, and it would appear quite certain that they must be of the same geological age. The species all appeared to be different from those hitherto known from the Plastic Clays, and will add materially to the fauna of that horizon.

Kaolin.—An outcrop of this material has recently been observed at low water on the shore of Staten Island, at the base of the bluff at Prince's Bay, between the grounds of the Light-house Department and the pier of the Catholic Children's Home. It is of the same mineral composition as that found near Kreischerville and alluded to by me in the ANNALS, II., 171 (1881). Indeed, it may be remarked that this substance is one of the most characteristic elements of the entire Plastic Clay series. No organic remains have as yet been obtained from it. Its geological position, as made out by Prof. Smock,[1] is nearly midway in the Plastic Clays, and it is only known from one horizon,—the bed averaging, in Middlesex County, N. J., ten feet in thickness, and probably a little more than that at

[1] N. J. Geol. Survey, Report on Clays, 1878, p. 34.

Kreischerville. It seems very similar to the material obtained by Mr. Merrill from the Long Island Cretaceous.

Cretaceous Gravel near Prince's Bay, Staten Island.

In a ravine near Prince's Bay is a large amount of white gravel, composed mainly of quartz, and intimately associated with an outcrop of kaolin. Mr. Hollick has recently discovered that this gravel contains numerous silicified fossils. They consist of a brachiopod mollusk, allied to *Pentamerus;* a cyathophylloid coral, perhaps *Zaphrentis*, a discoid mass, probably a sponge, and several fragments less certainly recognizable. This is one of the most interesting discoveries recently made in our local geology, and is of much more than local importance, inasmuch as it affords valuable evidence towards establishing the origin of the formation known as the Yellow Gravel or Preglacial Drift. I have been especially interested in this latter formation for several years, as it has been a much-debated question whence came the yellow gravel and sand composing it, and from which it derives its name. There were difficulties in the way of accepting the hypothesis, advanced by several eminent authorities, that it came either from the northwest or southeast. After a careful survey of a large part of the region where it is found in New Jersey, I arrived at the conclusion, as long ago as 1883, that it had been in large part derived from the erosion of Cretaceous strata containing gravel, outcropping in the vicinity, and that after erosion it had been colored by ferruginous waters.[1] That this coloring is merely superficial may be seen by breaking the pebbles composing the gravel and noting the white interior portions. The discovery of these fossils in the Cretaceous gravel goes far towards strengthening this conclusion,—for it is a well-known fact that similar fossils occur in the Preglacial Drift, and we have them now from the Prince's Bay Bluff and Todt Hill, Staten Island, as well as from all over southern Central New Jersey. The beds of white gravel must lie near the base of the Cretaceous system and form the exposures at Glen Cove, N. Y., and Camden, N. J. They are known to be of considerable thickness and extent; and as there is unmistakable evidence of some hundreds of feet of erosion from all this part of the country since the Cretaceous era, there is nothing extraordinary about the proposition. The problem still remains, however, where did these silicified fossils come from originally? We have traced them back one step further, from the Preglacial Drift to the Cretaceous gravels,

[1] TRANSACTIONS, IV., 33 (1884).

but that is as far as we can go at present. There are ledges of rock from which they might have been derived in Morris County, N. J.,[1] but the abundance of silicified fossils in the Preglacial Drift would seem to require some less remote source.

A remarkable feature of these gravel-beds is their immediate proximity, at all the known outcrops, to beds of the very finest mechanical sediments. Dr. Newberry was especially impressed with this occurrence at Glen Cove. It is the same at this new locality on Staten Island, and in the exposures at Fish House Station, near Camden, N. J., where I obtained a single silicified *Atrypa reticularis* when examining the clay-pits at that place with Professor Cook, in 1883. The gravel does not appear to form strictly continuous strata, and must vary greatly in thickness within very narrow limits of space.

[QUATERNARY.

The Ferruginous Quartz and "Jasperoid Rock" overlying the Serpentine at Hoboken and Staten Island.

This material appears to be of the same age as the limonite with which it is associated. The rock from Hoboken has been alluded to by Professor Cook in the "Geology of New Jersey" of 1868, but the exposures seen by him were not sufficient to afford any certain indication of its geological position. It may have been previously mentioned, but I have at present no earlier references. Professor Cook hazarded the supposition that "it was a part of the Red Sandstone (Triassic) formation, changed at its contact with the serpentine," and described it as silicious and hard. Mr. I C. Russell, in his paper on the "Geology of Hudson County,"[2] briefly describes it under the name "Jasperoid rock," which he states was given it by Professor Henry Wurtz some ten years before, or about 1870; but I have no other reference to Professor Wurtz in the matter. Mr. Russell referred it to the Archæan. but added, "We can offer little information concerning it." Professor Kemp visited the locality with me in 1886, and I recognized in some of the material then exposed an apparent identity with the ferruginous quartz rock of the hills on Staten Island. Here it is found in loose masses nearly all over the serpentine area. Sometimes it is very finely crystalline, and occasionally I have seen crystals nearly half an inch in

[1] See Merrill in Ann. Rep. State Geol. N. J., 1886, 134, where is shown the existence of silicified fossils in the Green Pond Mountain system, and the possibility of this source for some of the Preglacial gravel is briefly discussed.

[2] ANNALS of this Academy, II., 32 (1880).

length. At other places it is found as a mere amorphous and very hard mass. At certain points, as on Grimes Hill, back of Stapleton, it outcrops in place, but the glacier has scattered much of it far and wide. The limonite deposits all contain a considerable amount of it, and it is one of the features which call for a (at least) partially aqueous origin of the iron ores. I have nowhere observed it in greater thickness than three or four feet. In referring this substance to the Quaternary, I believe we have more nearly reached its actual horizon than either of the hypotheses above mentioned.

Boulder Clay at Arrochar, Staten Island.

A brick-yard has recently been established near the termination of the South Beach branch of the Staten Island Rapid Transit Railroad, on an outcropping layer of boulder clay. Extensive beds of morainal sand are associated with the clay.

PROF. D. S. MARTIN remarked upon several points in the paper, expressing great interest in the facts presented by DR. BRITTON, and welcoming especially the strong additional evidence given as to the Cretaceous age of the clays and gravels beneath the drift on the northern shore of Long Island. In reference to the term "jasperoid," he corroborated the statement made on the authority of Mr. Russell, and said that he was himself present at the meeting of the Academy (then the Lyceum) when Prof. Wurtz had discussed the rocks opposite the city, at Hoboken and Bergen, and had applied that name to this peculiar bed. He expressed much interest in DR. BRITTON'S correlation of it with the silicious and ferruginous deposits on Staten Island, and gave some further account of its mode of occurrence at Hoboken, where one or two outcrops now remain to be seen.

THE PRESIDENT followed in a similar strain of interest and appreciation. He spoke of the long-disputed problems as to the age of the northern Long Island beds, and the gradual accumulation of scattered evidence that has now become cumulative, as to their Cretaceous character. The paper just read may well be regarded as one of great value in local geological study.

DR. A. A. JULIEN, as the second paper of the evening, read a letter from DR. H. CARRINGTON BOLTON, dated April 10th, at Cairo, Egypt, upon

JEBEL NAGOUS AND A NEW MOUNTAIN OF THE BELL.

I have just returned from a journey of four weeks in the Desert of Mount Sinai, made with the especial object of studying the *Jebel Nagous* in connection with the joint researches of Dr. Alexis A. Julien and myself on *Musical Sand*. The "Mountain of the Bell" is situated on the Gulf of Suez, about four and a half hours from Tor by the roundabout camel route. It was first described by Seetzen in 1808, since which time it has been visited by Ehrenberg, Gray, Wellstedt, Rüppell, Ward, Newbold, Capt. H. S. Palmer, and the late Professor Palmer, as well as by large numbers of pilgrims. My observations confirm their accounts of the acoustic phenomena heard, but my measurements differ widely from those of all the travellers, save perhaps Professor Palmer.

The name Jebel Nagous is given by the Bedouins to a mountain nearly three miles long and about 1,200 feet high, composed of white sandstone bearing quartz pebbles and veins. On the western and northern side are several large banks of blown sand inclined at high angles. The sand on one of these slopes, at the N.W. end of the mountain, has the property of yielding a deep resonance when it slides down the incline either from the force of the wind or by the action of man. This bank of sand I distinguish from the others by calling it the *Bell Slope*. It is triangular in shape and measures 260 feet across the base, 5 to 8 feet across the top, and is 394 feet long (high). It has the high inclination of 31° quite uniformly. It is bounded by vertical cliffs of sandstone and is broken towards the base by projecting rocks of the same material. The sand is yellowish in color, very fine, and possesses at this inclination a curious mobility which causes it to flow, when disturbed, like treacle or pitch, the depression formed being filled in from above and advancing upward at the same time. The sand has none of the characteristics of sonorous sand found on beaches. When pulled downward by the hands, or pushed by the feet, a strong vibration is felt and a low note is plainly heard, resembling the deep bass of an organ-pipe. The loudness and continuity of the note are related to the mass of sand moved, but I think that those who compare it to distant thunder exaggerate. The bordering rocky walls give a marked echo, which may have the effect of magnifying and prolonging the sounds, but which, as I afterwards demonstrated, is not essential. There are no cavities for the sand to fall into, as erroneously reported. The peak of Jebel Nagous rises above the Bell Slope to the height of 955 feet above the sea level, as determined by a sensitive aneroid.

After studying the locality and phenomenon for several days,

I formed the opinion that it could not be unique, as hitherto supposed; and accordingly I tested every steep slope of blown sand met with on the caravan route northward to Suez. On April 6th, I examined a steep sand-bank on a hillock only 45 feet high, and was rewarded by the discovery of a second Nagous. This new Nagous is in the Wadi Werdan, only five minutes off the regular caravan route, and one and a half days from Suez by camels. The hillock is called by the Bedouins *Ramadan*, and forms the eastern end of a range of low hills about one-quarter of a mile long; being the only hills in the Wadi, the locality can easily be found by travellers. The hills consist of conglomerate, sandstone, and gypsum; they slope up gradually from the north and end in bold cliffs on the south side. Sand blown by the north wind is carried over the cliffs and rests on the steep face at two inclinations, 31° above and 21° or less below. By applying the usual tests with the hands to the fine-grained sand, I found that wherever it lies at the requisite angle to produce mobility (31°) it yielded the bass note, though not so loud as on the Bell Slope of Jebel Nagous. In one instance, my friend and fellow-traveller, Henry A. Sim, Esq., of the Madras Civil Service, who kindly aided me in my investigations, heard the sound while standing 100 feet distant.

The Nagous-sand occurs at intervals throughout the 500 yards of low cliffs; the main bank at the east end being 150 feet wide and 60 feet high, measured on the incline. I stirred up the mobile sand pretty thoroughly on this slope, and the next day it failed to give the sounds, not having recovered its properties. The intervening night was very cold (53° F.).

I feel confident that this phenomenon is not very rare in the desert, though the spontaneous production of sounds by sliding of the sand, as at Jebel Nagous, may be.

Whether the Rig-i-Rawan, north of Cabul, is caused by similar conditions, remains to be determined; but I fear that the peculiar relations existing between England and Russia will prevent my visiting northern Afghanistan.

Our dragoman, Hanna Abusab, and the Bedouins who accompanied us, were greatly astounded at my discovery of a new Nagous; and the faith of the latter in a monastery hidden in the heart of Jebel Nagous has received a severe shock. It is interesting to note that the Nagous, or wooden gong, is in daily use at the monastery of St. Catherine, Mt. Sinai.

I made photographs of Jebel Nagous and vicinity, as well as of the new Nagous, and collected specimens of the rocks, sand, etc. This communication must be regarded as a preliminary notice, full details being reserved for another paper.

I shall be obliged if those who have opportunities of examining

banks of dry and fine sand inclined at 31°, will report whether they yield deep sounds when disturbed.

May 20, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Eighty-four persons present.

The list of publications received since the last meeting was read.

The paper of the evening consisted of a lecture entitled

ICELAND, ITS HISTORY, PEOPLE, AND SCENERY,

by PROFESSOR CHARLES SPRAGUE SMITH, of Columbia College, illustrated with a series of lantern views, from photographs taken during the summer of 1888, and with specimens from the celebrated Iceland geysers.

The discovery of Iceland; its colonization and settlement in connection with political feuds and disturbances in Scandinavia; the new field of activity and enterprise opened to the Norse voyagers in the direction of Western exploration, as the increasing power and stability of the European nations cut off the possibility and profit of their marauding expeditions to the coasts lying south and east; the rise of Icelandic literature and the peculiarities of the language; the growth of a social and political system at once free, simple, and strong; the discovery of Greenland, and thence of the Western Continent;—were all treated of in very clear and interesting connection. PROF. SMITH then described the leading geographical features of the island, and the present state of society and life among its people.

A unanimous vote of thanks was tendered to the lecturer at the close.

May 27, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-eight persons present.

MR. WILLIAM E. HIDDEN remarked upon the recent discovery of gadolinite and other yttrium ores in Llano County, Texas, and upon the great promise of that region for yielding commercial quantities of the so-called "rare earths." He noted the occurrences, as identified by himself, of fergusonite, allanite, cyrtolite, uraninite, and fluorite, at this Texas locality. He also announced, as a preliminary notice, that he had, in conjunction with MR. J. B. MACKINTOSH, identified a new thorium mineral among the first lot of Texas specimens received. It conformed to a thorium silico-uranate, in which half the bases were uranates and half silicates. Forty-one per cent of thoria and 22 per cent uranic oxide were found, and a complete analysis is promised later. The mineral has a density of 4.43–4.54, and is tetragonal in form. Its color is yellowish brown. With it occurs a variety of uraninite having sp. grav. = 8.01, and containing a notable per cent of the yttria-ceria group of earths, which were thrown down by ammonium oxalate. It may also contain thoria. If this shall prove to be a true species, he suggested for it, provisionally, the name of *Chlorothorite*.

The locality has been thoroughly prospected since the beginning of the year, and work is now going on there in an endeavor to find marketable quantities of these rare minerals. Up to this time, the region has yielded about 500 pounds of gadolinite alone. One group of two crystals weighed 42 pounds,—an unprecedented size for the species. MR. HIDDEN said that he hoped soon to be able to supply a hundred pounds of yttria derived from minerals of this locality.

A full paper, with analyses of all the minerals of the district, will soon be completed and made public by MR. J. B. MACKINTOSH and Mr. HIDDEN, jointly.

DR. ALBERT R. LEDOUX then read the following communication:

THE PIPE-CREEK METEORITE.

The meteorite presented herewith was found by a farmer named J. W. Scott, in December, 1887, on the lands owned by the firm of F. W. Gross & Company, near Pipe Creek, Brandera County, Texas, thirty-five miles southwest of San Antonio. It was supposed to be an ore of some kind, and was broken up, and a piece sent to my firm to be assayed. Unfortunately the specimen was not particularly scrutinized, but, like other samples constantly coming in for assay, was handed to a man to pulverize, who succeeded in breaking up a large portion of it. The difficulty which he experienced in pulverizing it led to his bringing it to me, and to my giving it a more careful examination, when I saw that it was of meteoric origin. After considerable correspondence, I have obtained the whole of the specimen. It is here shown, minus the pulverized portion. It originally weighed thirty pounds, and, as described by the farmer who found it, its shape was "like a loaf of baker's bread." It is essentially a spheroid flattened on the side which struck the earth when it fell. It was clearly in a semi-fluid or pasty condition, and flattened out. The locality is prairie land, and the finder was attracted by the stone slightly protruding from the hard clay soil, quite near a roadway, down which he had often passed without previously observing the meteorite.

There is upon the exterior an oxidized crust showing the effect of heat and weathering. The interior has a somewhat crystalline appearance to the eye, thickly dotted with pellets or irregularly shaped nodules of soft iron, none of them larger than a quarter of an inch in diameter. Near the surface they are all rounded by the heat action. Examination of fragments with a microscope, and of a polished surface, shows, in addition to the metallic particles, iron pyrites, occasionally in perfect octahedra, and olivine,—both yellow and green varieties,—with amorphous silica or silicates.

I have given our fellow-member, Mr. George F. Kunz, a portion of the specimen, at his request, for micro-petrographic study of a thin section. I believe he intends to give you the result of his examination in the fall.

An examination of the fractured mass shows it to be of the ordinary type of stone meteorites. The color is gray, and lustre somewhat vitreous. The metallic particles are quite evenly distributed through the mass.

A chemical analysis was made as follows:—The metallic portion, by attrition and with the magnet, was freed from the stony matrix. The mass consisted, by weight, of

Metallic portion	30.89
Stony portion	69.11
	100.00

The metallic portion consisted of

Iron	90.94
Nickel	9.00
	99.94

In the stony portion, the following principal constituents making up the 69 per cent of matrix were determined:

Silica	35.61
Sulphur	3.45
Lime	2.25
Magnesia	15.09
Phosphorus	0.25
Iron (combined) calculated as Fe_2O_3, a little Al_2O_3	12.15

While this analysis is not complete, it serves to show the matrix to consist (besides the pyrites) of silicates. The metallic portion is the usual nickel-iron combination, of which the Caillé is perhaps the best type. The silicates, besides olivine, seem to have iron as the chief basic constituent.

In this connection, I will show another meteorite which I verbally described before this Academy in 1887. It is from Waldron Ridge, 10 miles northeast of Cumberland Gap, Tennessee. It weighs twelve pounds, and was found by a prospector for iron, who sent it to me for analysis in May, 1887. From the same locality, later in the year, a larger piece was also sent me, which, by order of the owner, I turned over to Mr. Kunz, and which he has described. It is of the ordinary nickel-iron variety, containing—

Iron	93.86
Nickel	6.01
	99.87

It undoubtedly belongs to the group of meteorites that have been found—all with similar characteristics—in Eastern Tennessee and Virginia, described by Kunz and others.

Mr. John Patten then read the paper announced for the evening, upon

THE CAUSE OF THE TIDES,

illustrated with an extensive series of diagrams, etc.

June 3, 1889.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Sixty-eight persons present.

The report of the Council was read, making various recommendations, etc., all of which were voted upon, and agreed to without dissent, to wit:

1. The election, as Resident Member, of

DR. JOHN S. RUSBY.

2. The payment of bills as follow:

Issue of TRANSACTIONS, Vol. VII., Nos. 3 and 4.....	$122 86
Reprinting portions of back volumes.....	46 35
Printing notices of meetings, etc., for two months.....	24 50
Expenses of Publication Committee during May.....	12 95
Miscellaneous items.....	4 75
	$211 41

3. The appropriation of $600 for publications, editorial work, and various expenses of the Academy during the summer months, as specified in detail in the report.

The paper of the evening consisted of a lecture entitled

THE RESULTS OF RECENT ARCHÆOLOGICAL EXCAVATIONS CONDUCTED AT ATHENS, MYCENÆ, TYRINS, EPIDOUROS, AND OLYMPIA,

by PROFESSOR A. C. MERRIAM, of Columbia College, late Superintendent of the American School of Archæology at Athens.

The lecture was extensively illustrated with maps and lantern views, and gave a highly interesting review of the manner and results of systematic investigation at these earliest seats of classical culture, and the changes involved in many of the received ideas embodied in treatises heretofore regarded as authoritative.

After adopting an enthusiastic vote of thanks to PROFESSOR MERRIAM, the Academy adjourned until the first Monday of October.

Charter, Order of Court, Constitution and By-Laws.

Charter.

AN ACT TO INCORPORATE THE

LYCEUM OF NATURAL HISTORY

IN THE CITY OF NEW YORK.

Passed April 20th, 1818.

WHEREAS, The members of the Lyceum of Natural History have petitioned for an act of incorporation, and the Legislature, impressed with the importance of the study of Natural History, as connected with the wants, the comforts, and the happiness of mankind, and conceiving it their duty to encourage all laudable attempts to promote the progress of science in this State—therefore,

Be it enacted by the People of the State of New York, represented in Senate and Assembly, That Samuel L. Mitchill, Casper W. Eddy, Frederick C. Schaeffer, Nathaniel Paulding, William Cooper, Benjamin P. Kissam, John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, and such other persons as now are, and may from time to time become members, shall be, and hereby are, constituted a body corporate and politic, by the name of LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK, and that by that name they shall have perpetual succession, and shall be persons capable of suing and being sued, pleading and being impleaded, answering and being answered unto, defending and being defended, in all courts and places whatsoever; and may have a common seal, with power to alter the same

from time to time; and shall be capable of purchasing, taking, holding, and enjoying, to them and their successors, any real estate in fee simple or otherwise, and any goods, chattels, and personal estate, and of selling, leasing, or otherwise disposing of the said real or personal estate, or any part thereof, at their will and pleasure: *Provided always*, that the clear annual value or income of such real or personal estate shall not exceed the sum of five thousand dollars: *Provided*, however, that the funds of the said corporation shall be used and appropriated to the promotion of the objects stated in the preamble to this act, and those only.

2. *And be it further enacted*, That the said Society shall, from time to time, forever hereafter, have power to make, constitute, ordain, and establish such by-laws and regulations as they shall judge proper, for the election of their officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of the officers and members thereof; for collecting annual contributions from the members towards the funds thereof; for regulating the times and places of meeting of the said Society; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for the managing or directing the affairs and concerns of the said Society: *Provided* such by-laws and regulations be not repugnant to the Constitution and laws of this State or of the United States.

3. *And be it further enacted*, That the officers of the said Society shall consist of a President and two Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and five Curators, and such other officers as the Society may judge necessary; who shall be annually chosen, and who shall continue in office for one year, or until others be elected in their stead; that if the annual election shall not be held at any of the days for that purpose appointed, it shall be lawful to make such election at any other day; and that five members of the said Society, assembling at the place and time designated for that purpose by any by-law or regulation of the Society, shall constitute a legal meeting thereof.

4. *And be it further enacted*, That Samuel L. Mitchill shall be the President; Casper W. Eddy the First Vice-President; Frederick C. Schaeffer the Second Vice-President; Nathaniel Paulding, Corresponding Secretary; William Cooper, Recording Secretary; Benjamin P. Kissam, Treasurer, and John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, Curators; severally to be the first officers of the said corporation,

who shall hold their respective offices until the twenty-third day of February next, and until others shall be chosen in their places.

5. *And be it further enacted*, That the present Constitution of the said Association shall, after passing of this Act, continue to be the Constitution thereof; and that no alteration shall be made therein, unless by a vote to that effect of three-fourths of the resident members, and upon the request in writing of one-third of such resident members, and submitted at least one month before any vote shall be taken thereupon.

State of New York, Secretary's Office.

I CERTIFY the preceding to be a true copy of an original Act of the Legislature of this State, on file in this Office.

ARCH'D CAMPBELL,
Dep. Sec'y.

ALBANY, *April 29th*, 1818.

Order of Court.

ORDER OF THE SUPREME COURT OF THE STATE OF NEW YORK

TO CHANGE THE NAME OF

THE LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK

TO

THE NEW YORK ACADEMY OF SCIENCES.

WHEREAS, in pursuance of the vote and proceedings of this Corporation to change the corporate name thereof from "The Lyceum of Natural History in the City of New York" to "The New York Academy of Sciences," which vote and proceedings appear of record, an application has been made in behalf of said Corporation to the Supreme Court of the State of New York to legalize and authorize such change, according to the statute in such case provided, by Chittenden & Hubbard, acting as the attorneys of the Corporation, and the said Supreme Court, on the 5th day of January, 1876, made the following order upon such application in the premises, viz.:

At a Special Term of the Supreme Court of the State of New York, held at the Chambers thereof, in the County Court House, in the City of New York, the 5th day of January, 1876:

Present—HON. GEORGE C. BARRETT, *Justice.*

In the matter of the application of the Lyceum of Natural History in the City of New York to authorize it to assume the corporate name of The New York Academy of Sciences.

On reading and filing the petition of the Lyceum of Natural History in the City of New York, duly verified by John S. Newberry, the President and chief officer of said Corporation, to authorize it to assume the corporate name of the New York Academy of Sciences, duly setting forth the grounds of the said application, and on reading and filing the affidavit of Geo. W. Quackenbush, showing that notice of such application had been duly published for six weeks in the State paper, to wit, *The Albany Evening Journal*, and the affidavit of David S. Owen, showing that notice of such application had also been duly published in the proper newspaper of the County of New York, in which county said Corporation has its business office, to wit, in the *Daily Register*, by which it appears to my satisfaction that such notice has been so published, and on reading and filing the affidavits of Robert H. Brownne and J. S. Newberry, thereunto annexed, by which it appears to my satisfaction that the application is made in pursuance of a resolution of the managers of said Corporation to that end named, and there appearing to me to be no reasonable objection to said Corporation so changing its name, as prayed in said petition: Now, on motion of Grosvenor S. Hubbard, of Counsel for Petitioner, it is:

Ordered, That the Lyceum of Natural History in the City of New York be and is hereby authorized to assume the corporate name of The New York Academy of Sciences.

Indorsed: Filed January 5, 1876.

A copy. WM. WALSH, *Clerk.*

Resolution of the ACADEMY, *accepting the order of the Court, passed February* 21, 1876.

And whereas, The order hath been published as therein required, and all the proceedings necessary to carry out the same have been had, Therefore:

Resolved, That the foregoing order be and the same is hereby accepted and adopted by this Corporation, and that in conformity therewith the corporate name thereof, from and after the adoption of the vote and resolution hereinabove referred to, be and the same is hereby declared to be

THE NEW YORK ACADEMY OF SCIENCES.

CONSTITUTION.

ARTICLE I.

This Society shall be styled The New York Academy of Sciences.

ARTICLE II.

It shall consist of four classes of members, namely: resident members, corresponding members, honorary members, and fellows. Resident members shall be such as live in or near the City of New York; corresponding members, such as reside at a distance from said city; and honorary members, such as may be judged worthy, from their attainments in science, to be admitted into the Academy. The number of honorary members shall not exceed fifty. Fellows shall be chosen from among the resident members, in virtue of scientific attainments or services.

ARTICLE III.

All fellows and members shall be elected by ballot. The names of candidates shall be proposed in writing, at least two meetings previous to being balloted for. The affirmative votes of three-fourths of the fellows and members present shall be necessary to elect a candidate; honorary or corresponding members, however, may be elected without previous notice, provided that the ballot on such election is unanimous.

ARTICLE IV.

None but fellows or resident members shall be entitled to vote in the Academy.

ARTICLE V.

No fellow or member who shall be in arrears for one year shall be entitled to vote or be eligible to any office in the Academy.

ARTICLE VI.

The officers of the Academy shall consist of a president, a first and a second vice-president, a corresponding secretary, a recording secretary, a treasurer, five curators, and a librarian, who shall be chosen annually on the fourth Monday in February.[1] The president, vice-presidents, and secretaries shall be fellows. There shall also be elected, at the same time, a finance committee of three.

ARTICLE VII.

There shall be elected at the annual meeting six members, at least three of whom shall be fellows, who, together with the president, the vice-presidents, the two secretaries, and the treasurer, shall constitute a Council, by whom all business, to be brought before the Academy, shall ordinarily be prepared. Vacancies occurring in the offices or in the Council of the Academy in the interval between the annual elections, may be filled for the unexpired term by special election at any regular business meeting, provided notice of such election shall have been given at a previous regular business meeting.

ARTICLE VIII.

The election of officers and of the Council shall be by ballot, and the candidates having the greatest number of votes shall be declared duly elected.

ARTICLE IX.

Five members at an ordinary meeting shall form a quorum, and ten at a special or business meeting, a majority of whom, in either case, shall be fellows.

ARTICLE X.

By-laws for the further regulation of the Society may from time to time be made.

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[1] See eighth line of Section 3 of the Charter.

ARTICLE XI.

[1] No alteration shall be made in this Constitution, unless by a vote to that effect of three-fourths of the fellows and three-fourths of the resident members entitled to vote under Article V.

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[1] This clause must be taken in connection with Section 5 of the Charter, which requires a previous request in writing of one-third of all the resident members (which must be considered in this case as including fellows, as that class of members was not in existence at the time the Charter was granted), submitted one month previous to any vote being taken.

BY-LAWS.

CHAPTER I.—*Of Members and Fellows.*

1. No person shall be considered a resident member until he shall have signed the Constitution and paid his initiation fee; and unless the candidate shall comply with these conditions within six months from the date of his election, such election shall be void. No member in arrears shall be eligible as a fellow.

2. A resident member or fellow removing permanently from the city may, on giving notice thereof, and on payment of his arrears, become a corresponding member; and a corresponding member who removes to the city, with an intention of making it his permanent residence, may become a resident member on complying with the provisions of the first section of this chapter.

3. No person not engaged in the pursuit of some branch of science shall be elected a corresponding member.

CHAPTER II.—*Of Original Subscriptions.*

1. Every holder (whether original subscriber, transferee, or legatee) of a receipt for the sum of one hundred dollars, paid into the treasury of the New York Lyceum of Natural History towards the liquidation of the debt incurred by the erecting of the building formerly the property of the Lyceum, in Broadway, in this city, shall be entitled for himself and his family to free admission to the Museum of the Academy, and to such public lectures as may be delivered on its behalf, which the members have a right to attend. He shall be entitled to the use of the books of the Library; and shall have the privilege of introducing strangers to the Museum and Library, in accordance with the regulations of the Academy.

CHAPTER III.—*Of Patrons and Life-Members.*

1. Any person may become a patron of the Academy of Sciences by contributing, at one time, two hundred and fifty dollars toward the fund for the general purposes of the Society.

2. A patron shall, during his life, be entitled, for himself and his

immediate family, to the same privileges as an original subscriber, and shall be entitled to one copy of all the scientific publications of the Academy appearing subsequent to the date of the payment of his contribution.

3. Any resident member may become a life-member by contributing at one time one hundred dollars toward the fund for the general purposes of the Society, and shall thereafter be exempt from annual dues.

CHAPTER IV.—*Of Officers.*

1. The President, or, in his absence, one of the Vice-Presidents, or, in their absence, a Chairman *pro tempore*, shall preside at all meetings of the Academy, and shall have a casting vote. He shall preserve order, and shall decide all parliamentary questions, subject to an appeal to the Society. He shall appoint all committees authorized by the Academy, unless otherwise specially ordered.

2. The Corresponding Secretary shall be charged with the correspondence of the Academy. It shall be his duty to be present at all its meetings, to read all communications made to him in his official capacity; to keep a book in which shall be recorded the correspondence of the Academy, and the names of all corresponding members; to lay the same on the table at all regular meetings thereof; to notify corresponding and honorary members of their election; and to report to the Academy on the fourth Monday of February, annually, the state of its correspondence.

3. The Recording Secretary shall be present at all meetings of the Academy, and keep a record of the proceedings thereof. He shall take charge of all papers and documents belonging to the Society; shall keep a corrected list of members and fellows; shall notify all resident members and fellows of their election, and committees of their appointment; and shall give notice to the Treasurer and to the Council of all matters requiring their action.

4. The Treasurer shall have charge of all moneys belonging to the Academy, and, under its orders, of their investment, and shall give good and satisfactory security to the Society for the faithful discharge of the trust, in a sum not less than five thousand dollars. He shall collect initiation fees and annual dues from all members and fellows, all subscriptions made in behalf of the Academy, and any income that may accrue from property belonging to the institution; shall report at the business meeting in January the names of members in arrears; shall give due notice to the Society of the expiration of all policies of insurance that may be effected on its property; and pay all debts against the Society which shall have

been audited by the Committee of Finance, or the discharge of which shall have been ordered by the Academy at a regular business meeting. He shall furnish the Committee of Finance, on due application, with such information of the state of the funds as they may require; and shall report to the Academy, at each business meeting, the condition of its finances, and on the fourth Monday of February, the receipts and expenditures of the entire year.

5. The Librarian shall have immediate supervision and care of the Library, under the general authority of the Library Committee of the Council. All accessions to the Library shall pass through his hands, and he shall enter the titles to the same in a suitable book kept for that purpose. He shall indelibly stamp every book, pamphlet, paper, or other matter, with the stamp of the Society, as prescribed by the Library Committee or Council. He shall periodically make a detailed report of accessions, and on the fourth Monday in February shall make an Annual Report on the condition of the Library.

6. The Curators shall be separately charged with the safe-keeping and arrangement of the several collections, and with the keys of the cabinets. Each Curator shall have his particular department allotted to him when elected. All regulations made by the Curators shall be reported to the Council, and approved of by the Academy, before such regulation shall come into operation.

7. The Curator having charge of any division of the collection, shall alone be authorized to select duplicate specimens from such division for the purpose of exchange or donation; but no exchange or donation shall be made, except such as is authorized by a vote of the Society.

8. The increase and improvement of the collections being the inducement to exchange, it shall be the duty of the Curators to report to the Society all such opportunities to exchange as would favor this object.

CHAPTER V.—*Of the Council.*

1. The President, Vice-Presidents, and Secretaries of the Academy, shall hold the same offices in the Council. In the absence of any of them, officers *pro tempore* may be appointed.

2. The Council shall meet at least once a month, within ten days preceding the regular business meeting of the Academy. Minutes shall be kept of its proceedings, which may be called for at any business meeting, upon a vote of the Academy. Matters of

a strictly personal nature, however, need not be entered on the minutes of the Council.

3. Five members of the Council, a majority of whom shall be fellows, shall constitute a quorum; but the Council may appoint an Executive Committee, or business may be transacted at a regularly called meeting of the Council at which less than a quorum is present, subject to the written approval of a majority of the Council, subsequently given to the Secretary, and recorded by him with the minutes.

4. The Council shall prepare all business referred to it by the Academy, and may present any other business at its discretion. It shall frame its own rules and regulations, and determine the time and place of its meetings.

5. The Council shall organize within itself a Committee on Nominations, a Committee on Publication, and a Committee on the Library, to whom, in the intervals of the meetings of the Council, all matters pertaining to these several subjects shall be referred. Their action shall always be subject to the revision of the Council. The names of the persons composing these committees shall be kept publicly posted in the rooms of the Academy.

6. All business prepared by the Council shall be presented to the Academy by the Recording Secretary, or, in his absence, by some other officer of the Council. But the Council may decline to present business at any meeting at which a majority of those present shall not be fellows.

CHAPTER VI.—*Of Committees.*

1. The Committee on Finance shall audit all accounts against the Academy, and shall have the duties and powers of a Committee of Ways and Means. They shall report on financial questions referred to them, whenever called upon to do so by the Academy or the Council.

2. Committees for Special Purposes may be appointed when required.

CHAPTER VII.—*Of Sections.*

1. Sections of special branches of science may be established or abolished by the Academy upon the recommendation of the Council and one month's notice.

2. Sections shall be organized with at least a Chairman and a Secretary, and these officers may take charge of the meeting of their section during the presentation of its scientific busines.s

CHAPTER VIII.—*Of Initiation Fees, Annual Dues, etc.*

1. Every resident member, at the time of his admission, shall pay into the treasury, as an initiation fee, the sum of ten dollars. All members who become fellows shall pay into the treasury an initiation fee of ten dollars. Resident members and fellows shall be subject to pay an annual fee of ten dollars.[1]

2. Any resident member or fellow coming under the provision of Chapter II., or who becomes a Patron or a Life-member, shall be exempt from all future annual dues.

3. The Academy may, on account of services, exempt any member or fellow from his annual dues, provided the proposal be made at a regular business meeting, be approved by the Council, lie over until the next regular business meeting, and all the members then present agree thereto.

4. If any resident member or fellow, in arrears for his annual dues for over one year, shall neglect or refuse to liquidate the same within three months after notification by the Treasurer, his name may be erased from the rolls by a two-thirds vote of the members and fellows present at any regular business meeting of the Society; provided that such action shall have been recommended by the Council and at least one month's notice given in writing to the delinquent to show cause why such erasure should not be made.[2]

5. All contributions received under the provisions of Section 2 of this Chapter, as also those received from the patrons, shall be invested in United States or in New York State securities, and the income derived therefrom be applied to the general purposes of the Academy.

CHAPTER IX.—*Of the Publications.*

1. The publications of the Academy shall consist of the Annals and the Transactions, and such other documents as shall be ordered by the Academy.

2. The publications shall be issued under the supervision of the Committee of Publication, and shall be furnished to members, fellows, and subscribers at such rates as may be determined by the Academy.

3. No member or fellow shall publish any part of the proceedings of the Academy, nor any paper read before it, without the consent of the Council, or by a resolution of the Academy.

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[1] Corresponding and honorary members are exempt from initiation fees and annual dues, as are life-members and patrons.

[2] See Section 2 of the Charter.

CHAPTER X.—*Of the Publication Fund.*

1. Contributions may be received towards establishing a Publication Fund; all such contributions shall be invested in United States or in New York State securities, and the income thereof be applied toward defraying the expense of the scientific publications of the Academy.

2. Contributors to this fund in the sum of one hundred dollars, or more, at one time, shall be entitled to one copy of all the scientific publications of the Academy appearing subsequently to the date of the payment of their contribution.

CHAPTER XI.—*Of the Museum.*[1]

1. All donations shall have the names of the donors affixed thereto.

2. All members shall have access to the Museum, subject to the regulations of the Academy.

3. All deposited specimens shall be labelled with the name of the depositor, and, while they remain as such, shall be exclusively under the control of the Academy, and subject to the same uses and regulations as the specimens belonging to it.

4. No person, making a deposit of specimens, shall be allowed to remove them without giving a receipt for the same to the Curator in charge.

5. No specimen contained in the Museum shall be loaned, unless by special permission of the Academy.

6. The Curators shall arrange, in systematic order, all the specimens belonging to the Museum, and keep a catalogue of the same; and shall report, on the fourth Monday in February in each year, the state of the property confided to their charge.

CHAPTER XII.—*Of the Library.*

1. The Library shall be under the control of the Librarian and the Library Committee.

2. No book shall be purchased, or other expense incurred for the Library, except by a recommendation to that effect signed by a majority of the Library Committee, and ratified by the Council.

3. The Library Committee shall designate such books as ought not to be removed[2] from the rooms of the Academy, which shall

[1] This chapter has been practically suspended, on account of the destruction of the Museum by fire.

[2] By the present rule, no book can be so removed without special permission from the Council.

be marked on the catalogue, and shall not be taken out without special permission from the Academy.

4. The Librarian shall be furnished with a book, in which he shall keep a regular account of all books borrowed and returned, by inserting the name of the borrower and the book borrowed, the time when taken out and when returned. In the absence of the Librarian, one of the Library Committee shall keep this record.

5. A volume, not returned within one month, shall incur a fine of fifty cents, and twenty-five cents for each week thereafter.

6. Any injury done to works shall be estimated by the Committee, and the borrower fined accordingly.

7. The Librarian shall report to the Treasurer, from time to time, the fines imposed.

8. No member or fellow shall take out more than two volumes at one time, without special permission from the Council.

9. On the first Monday in June, all books shall be called in; and the Library Committee shall examine the Library, and compare it with the catalogue. They shall note all missing books, and report the same, at the next meeting, to the Academy.

CHAPTER XIII.—*Of Meetings.*

1. The ordinary meetings shall be held on Monday evening in each week.

2. The President, or either of the Vice-Presidents, with any five members or fellows, may call a Special Meeting.

3. Special Meetings shall be called by a notice sent to each resident member and fellow, stating the time at which such meeting is to be held, and the object for which it is called.

4. The meeting held on the fourth Monday in February shall be considered a special business meeting.

5. Ordinary meetings shall be held in such places as shall be determined by the Academy or Council. When meetings are not held in the rooms of the Academy, it shall be the duty of the Recording Secretary to notify all the fellows and members of the time and place of meeting. All business meetings shall be held in the rooms of the Academy.

6. Visitors at the meetings shall be introduced by one or more members, and their names shall be announced by the President, and entered on the minutes.

CHAPTER XIV.—*Of Business.*

1. All business other than such as relates immediately to the cultivation of science shall be transacted at the first meeting of

each month only,—except when the Council shall report it as urgent, in which case it may be transacted at any meeting, provided at least a week's notice shall have been given to all members and fellows.

2. The following shall be considered the regular order of business at the ordinary meetings:

1. The minutes of the preceding ordinary meeting read, and the sense of the members taken thereon.
2. The names of visitors announced.
3. Signing of the Constitution by new members.
4. Announcement of additions to the Library or Cabinets.
5. Examination of specimens exhibited.
6. Report of committees not of a business character.
7. Presentation and discussion of papers previously announced.
8. Any other scientific business.
9. Rough minutes read.
10. Adjournment.

3. The following shall be considered the order of business at the regular business meetings:

1. The minutes of the preceding business meeting read, and the sense of the members taken thereon.
2. The names of visitors announced.
3. Signing of the Constitution by new members.
4. Announcement of additions to the Library or Cabinets.
5. Report of the Council.
6. Reports of Officers.
7. Reports of Committees.
8. Deferred business.
9. New business.
10. Elections.
11. Scientific business.
12. Rough minutes read.
13. Adjournment.

4. The Rules of Order as set forth in "Cushing's Manual of Parliamentary Practice" shall be accepted as authoritative in the meetings of the Society.

CHAPTER XV.—*Of Elections.*

1. The Annual Elections shall be conducted as follows:

Nominations may be sent in writing to the Recording Secretary, with the names of the proposers, at any time not less than thirty

days before the Annual Meeting; and the Council shall prepare, from the names so proposed, a list which shall constitute the regular ticket. This list shall be furnished to every resident member and fellow at least two weeks before the Annual Election, and be publicly posted during that time in the rooms of the Academy. But any resident member or fellow shall be at liberty to alter this list, or to prepare another.

The ballots shall be received and examined by at least two tellers appointed by the presiding officer at the Annual Meeting. A list of the persons who have received the greatest number of votes of those present, certified by the tellers, shall then be presented by them to the presiding officer, who shall thereupon declare the said persons elected to their respective offices, and shall present the list to the Recording Secretary, who shall enter it on the minutes and file it; the ballot shall be destroyed as soon as the certified list is handed to the presiding officer.

2. Elections for members and fellows shall be held on the first meeting of each month only. Resident members shall be elected as follows: The candidates shall be proposed publicly, in writing, at any meeting, by a fellow or member; and the nominations, together with the name of the person making them, shall be referred to the Council; the report of the Council shall be openly read at the next regular business meeting, upon which the Academy will proceed to a ballot.[1] Names of candidates for honorary membership may be presented by the Council.

3. Fellows shall be elected as follows: Candidates shall be recommended to the Council in writing, with the reasons for such recommendation, signed by the proposer; then, if the Council see fit, it shall publicly nominate them at a regular business meeting, and the names of such nominees shall be entered on the minutes, and then be posted in some conspicuous place during all meetings held in the rooms of the Academy, at least until the next regular business meeting. They shall be balloted for in the same manner as resident members.

CHAPTER XVI.—*Of General Provisions.*

1. No expenditure shall be incurred on behalf of the Academy, or disbursements made, unless authorized by a vote of a majority of the members and fellows present at a business meeting.

2. Any member or fellow may be censured, suspended, or ex-

[1] See Article 3 of the Constitution.

pelled, for violation of the Constitution or By-Laws, or for any other offence deemed sufficient, by a vote of three-fourths of the members and three-fourths of the fellows present at any regular business meeting; *provided* that such action shall have been recommended by the Council at a regular business meeting, and one month's notice of such recommendation, and of the offence charged, shall have been given the member accused.

3. No alteration shall be made in these By-Laws, unless such alteration be submitted publicly in writing, at a regular business meeting, be entered on the minutes with the name of the member or fellow proposing the same, and be adopted by two-thirds of the members and two-thirds of the fellows present at a subsequent regular business meeting.

Patrons of the Academy.[1]

[Those marked with an asterisk are deceased.]

* Bland, Thomas,
Bolton, Prof. H. Carrington,
* Brevoort, J. Carson,
Cotheal, Alex. J.,
* Delafield, Joseph,
* Dinwiddie, Robert,
Dodge, William E.,
Egleston, Prof. Thos.,
* Elsberg, L., M.D.,
Field, C. de Peyster,
Greene, J. W., M.D.,
Grinnell, Geo. B.,
Hinton, John H., M.D.,
Lawrence, Geo. N.,
Leeds, Prof. Albert R.,
* Lenox, James,
Livingston, Robert J.,
Newberry, J. S., M.D.,
Prime, Frederick E.,
Prime, Temple,
Sloan, Samuel,
Steward, D. Jackson,
* Storrs, Charles,
* Stuart, Robert L.,
* Suckley, Geo., M.D.,
* Van Nostrand, H. D.,
* Van Rensselaer, Alex.,
Weston, Henry,
* Wheatley, Charles M.,
* Wolfe, Miss Catherine L.

Contributors to the Publication Fund.[2]

[Those marked with an asterisk are deceased.]

Amend, Bernard G.,
American Bank Note Co., A. D. Shepard, Vice-Prest.,
Chamberlain, W. L.,
Coddington, T. B.,
Collingwood, F.,
Crosby, Rev. Howard,
Dodge, Wm. E.,
* Elsberg, L., M.D.,
Herrman, Mrs. H.,
Hildenbrand, W.,
Hoe, Henry,

[1] See By-laws, Chapter III., and Chapter VIII., Section 2.
[2] See By-laws, Chapter X.

Julien, Alexis A.,
Krotel, Rev. G. F.,
Lawrence, Geo. N.,
Le Comte, Joseph,
* Lenox, James,
Lord, Franklin B.,
Prime, Temple,
Pyne, Percy R.,
Newberry, J. S., M.D.,
Redfield, John H.,
* Reinhart, B. F.,
Schuyler, Philip,
* Stengel, Prof. Fred.,
Steward, D. Jackson,
* Stuart, Robert L.,
Van Beuren, Fred. T.,
Waller, Elwyn,
Weston, Edward W.,
* Wolfe, John D.

Resident Fellows and Members.

(F.) Fellows.
(P.) Patrons.
(S.) Subscribers to Building Fund.

Abbott, Frank, M.D., 22 West 40th Street.
Adams, J. W., 155 Congress Street, Brooklyn.
Allen, Prof. J. A., American Museum of Natural History, **F.**
Allen, T. F., M.D., 10 East 36th Street, **F.**
Allen, W. F., 46 Bond Street.
Amend, B. G., 120 East 19th Street, **F.**
Arnold, E. S. F., M.D., Hotel Bristol, **F.**
Atterbury, Rev. Anson P., 117 West 87th Street.

Bailey, James M., 77 Madison Avenue.
Banks, David S., 33 West 39th Street.
Barker, Fordyce, M.D., 24 East 38th Street, **F.**
Bartlett, J. W., M.D., 149 West 94th Street.
Beach, Alfred E., 361 Broadway.
Beck, Fanning C. T., 61 East 55th Street, **F.**
Bernacki, Charles, M.D., 36 West 28th Street.
Bickmore, Prof. A. S., Amer. Museum of Natural History, **F.**
Bien, Julius, 139 Duane Street.
Biggs, Charles, 610 Broadway.
Bjerregaard, Augustin P., Astor Library.
Boas, Franz, M.D., 196 Third Avenue, **F.**
Bolton, Prof. H. C., Ph.D., University Club, **F.**
Bonnett, Chas. P., Elizabeth, N. J.
Bower, William, 53 Fulton Street.
Britton, N. L., Ph.D., Columbia College, **P., F.**
Brown, Hon. Addison, 233 East 48th Street, **F.**
Brown, John Crosby, 59 Wall Street.

Brownell, Silas B., 139 West 53d Street, **F.**
Brownne, John S., 12 West 31st Street.
Brush, Prof. Chas. G., 349 West 56th Street.

Caffall, Robert M., 230 West 22d Street.
Cary, Albert A., 234 West 29th Street.
Casey, Capt. Thomas L., Army Building, Whitehall St., **F.**
Caswell, John H., 11 West 48th Street, **F.**
Chandler, Prof. Charles F., Columbia College, **F.**
Cheney, Alfred C., Garfield Nat. Bank, 23d St. and Sixth Ave.
Chittenden, L. E., 49 East 65th Street, **F.**
Christern, F. W., 254 Fifth Avenue.
Church, Benjamin S., 54 West 12th Street.
Close, S. L., M.D., 48 East 31st Street.
Colby, Charles E., Columbia College.
Collingwood, Francis, C.E., Elizabeth, N. J., **F.**
Congdon, Ernest A., 31 Broadway.
Conklin, W. A., Arsenal Building, Central Park.
Conkling, Alfred R., 27 East Tenth Street.
Constant, S. Victor, 405 West 21st Street.
Cooper, Hon. Edward, 12 Washington Square.
Cotheal, Alexander J., 62 West 36th Street, **P., F.**
Cox, Charles F., 100 East 17th Street, **F.**
Crooke, John J., 165 Mulberry Street, **F.**

Daly, Hon. Charles P., 84 Clinton Place, **F.**
Davies, William G., 32 Nassau Street.
Day, Austin G., 16 Dey Street.
Day, Prof. Edward H., 1187 Lexington Avenue, **F.**
Deane, Bashford, College of the City of New York.
Dederick, E. H., 18 Maiden Lane.
Devoe, Frederick W., P. O. Box 460.
Dewitt, William G., 88 Nassau Street.
Dickerson, Edward N., 7 Beekman Street, **F.**
Diehl, Mrs. Anna Randall, 56 West 55th Street.
Dittenhoefer, A. J., 96 Broadway (Room 140).
Dix, Rev. Morgan, D.D., 27 West 25th Street.
Dodge, William E., 262 Madison Avenue, **P.**

Doremus, Charles A., Ph.D., 92 Lexington Avenue, **F.**
Doremus, Prof. R. Ogden, M.D., 17 Lexington Avenue, **F.**
Douglass, Andrew E., 9 East 54th Street, **F.**
Drummond, Isaac W., 101 Horatio Street.
Drummond, James F., 436 West 22d Street.
Du Bois, Eugene, 23 Park Row.
Dudley, Henry, 56 West 57th Street, **F.**
Dudley, P. H. (Room 14), Grand Central Depôt, **F.**
Dwight, Jonathan, Jr., 2 E. 34th Street.

Edison, Thomas A., Orange, N. J., **F.**
Egleston, Prof. Thomas, 35 West Washington Square, **P., F.**
Elseffer, William L., C.E., 122 East 23d Street, **F.**

Fargo, James C., 56 Park Avenue.
Farrar, Dr. John N., 1271 Broadway.
Field, C. de Peyster, 21 East 26th Street, **P.**
Fink, Albert, 346 Broadway.
Fischer, Charles S., Jr., M.D., 110 West 128th Street.
Fish, Hon. Hamilton, 251 East 17th Street, **S.**
Friedrich, James J., M.D., 124 East 59th Street.

Gallatin, Albert R., 10 East 17th Street, **F.**
Gould, George, 1 East 47th Street.
Gouley, J. W. S., M.D., 324 Madison Avenue.
Gratacap, Louis P., American Museum of Natural History.
Green, Hon. Andrew H., 214 Broadway.
Grinnell, George B., 41 Park Row, **P.**
Guernsey, Egbert, M.D., 526 Fifth Avenue.
Gurnee, Walter S., 7 Nassau Street.

Hale, Albert W., 1 Broadway.
Hall, Prof. Robert W., 712 Fifth Avenue.
Hamilton, Rev. Samuel M., 62 West 11th Street.
Hartt, James C., 21 Cortlandt Street.
Hascall, Mrs. Virginia K., 110 East 16th Street.
Haswell, Charles H., 29 Broadway.
Heineman, Henry N., M.D., 49 West 57th Street.

Henderson, John C., 108 West 40th Street.
Herrman, Mrs. Esther, 59 West 56th Street, **P.**
Hewitt, Hon. Abram S., 9 Lexington Avenue, **F.**
Hildenbrand, William, 222 West 24th Street.
Hildreth, D. M., 48 Irving Place.
Hinton, John H., M.D., 41 West 32d Street, **P., F.**
Hitchcock, Miss F. R. M., 41 West 73d Street, **F.**
Hitchcock, Hiram, Fifth Avenue Hotel.
Holbrook, Levi, 128 West 59th Street.
Hoe, Henry, 91 John Street.
Hooper, Prof. Franklin W., 71 St. James Place, Brooklyn.
Hoyt, Alfred M., 1 Broadway.
Hoyt, Henry, 53 William Street, **S.**
Hubbard, Prof. O. P., M.D., 65 West 19th Street, **F.**
Hubbard, Walter C., 27 West Ninth Street.
Hyde, E. Francis, 54 Wall Street.

Ireland, John B., 170 Broadway.

Jacobi, Abram, M.D., 110 West 34th Street, **F.**
Jacoby, L. H., Columbia College.
James, D. Willis, 40 East 39th Street.
Jay, Hon. John, 242 East 15th Street, **S.**
Jay, John C., M.D., 17 West 46th Street, **S.**
Julien, Alexis A., Ph.D., Columbia College, **F.**

Ketchum, Mrs. A. C., 109 East 86th Street.
Kimber, Rev. Arthur C., 105 East Houston Street.
King, Prof. Clarence, Brevoort House, **F.**
Kunz, George F., Hoboken, N. J., **F.**

Lamb, Mrs. Martha J., Coleman House.
Lamborn, R. H., Ph.D., care of Mexican Nat. R. R. Co., 32 Nassau Street, **F.**
Larremore, Hon. R. L., 32 E. 60th Street.
Laudy, Louis H., Ph.D., Columbia College.
Law, Walter W., 882 Broadway.
Lawrence, George N., 45 E. 21st Street, **P., F.**

Le Comte, Joseph, 231 Front Street.
Ledoux, Albert R., Ph.D., 39 West 50th Street, **F.**
Lee, J. Lawrence, M.D., 21 W. 17th Street.
Leeds, Prof. A. R., Stevens Institute, Hoboken, N. J., **P., F.**
Levison, W. Goold, 314 Livingston Street, Brooklyn, **P., F.**
Lewis, W. H., Jr., 63 West 19th Street.
Liautard, A., M.D., 141 West 54th Street.
Lichtenstein, Paul, Cotton Exchange Building, N. Y.
Lindley, C. L., M.D., 85 Madison Avenue.
Livingston, Robert J., 10 East 48th Street, **P.**
Lockman, Jacob K., 48 West 51st Street.
Loewenthal, Herman, M.D., 127 East 84th Street.
Lord, Benjamin, M.D., 34 West 28th Street.
Low, Hon. Seth, 31 Burling Slip.

Marble, Manton, 532 Fifth Avenue.
Marquand, Henry G., 11 East 68th Street, **F.**
Martin, Prof. Daniel S., 236 West Fourth Street, **F.**
Martin, Edward W., 256 W. 57th Street.
Maynard, Prof. George W., 35 Broadway.
McCarty, Edwin R., St. James Hotel.
McClintock, Emory, Mutual Life Ins. Co. N. Y.
McDonald, John, 11 Pine Street, **F.**
McNulty, George W., C.E., 53 Broadway.
Mead, Walter H., 65 Wall Street, **P.**
Merrill, Fred. J. H., Fordham Heights, N. Y., **F.**
Mitchell, Edward, 31 East 50th Street.
Mitchell, John Murray, 43 Wall Street.
Moldehnke, Richard G., 124 East 46th Street.
Moore, Gideon E., Ph.D., 69 Liberty Street, **F.**
Morse, J. H., 423 Madison Avenue.
Mott, Henry A., Jr., Ph.D., 100 Broadway.
Mulcahey, Rev. James, 65 Church Street.
Munsell, C. E., Ph.D., 223 W. 14th Street.

Neftel, J. W. K., 41 Liberty Street.
Newberry, Prof. J. S., M.D., Columbia College, **P., F.**
Newton, H. J., 128 West 43d Street, **F.**

Northrup, John J., Columbia College.
Nott, F. J., M.D., 522 Madison Avenue.

Otis, Fessenden N., M.D., 5 West 50th Street, **F.**
Ottendorfer, Oswald, M.D., 7 East 17th Street.

Parmly, D. D., 160 Broadway.
Parsons, William Barclay, Jr., 505 Fifth Avenue.
Patten, John, 70 West 50th Street.
Peabody, Hon. Charles A., 60 West 21st Street.
Pellew, Charles E., 51 East 54th Street, **F.**
Phelps, Hon. William W., 2 Wall Street.
Pitkin, Lucius, Ph.D., 138 Pearl Street, **F.**
Poggenburg, Justus F., 447 East 57th Street, **F.**
Potter, Rt. Rev. Henry C., 160 West 59th Street.
Potter, Orlando B., Potter Building, Park Row.
Prime, Frederick, 26 Broad Street, **S.**
Prime, F. E., 26 Broad Street, **P.**
Prime, Temple, 26 Broad Street, **P.**
Pyne, Percy R., 52 Wall Street.

Rawson, A. L., Broadway cor. 58th Street.
Rees, Prof. John K., Columbia College, **F.**
Rice, Charles, Ph.D., Bellevue Hospital.
Ricketts, Pierre de P., Ph.D., Columbia College, **F.**
Rickoff, Andrew J., LL.D., 64 West 52d Street.
Ripley, John H., M.D., 605 Lexington Avenue.
Rogers, Isaac L., 33 West 25th Street.
Roosevelt, Frank, 58 West 15th Street.
Rousseau, David, 310 Mott Avenue.
Rusby, Henry H., M.D., Columbia College, **F.**
Rutherford, Lewis M., 16 Exchange Place, **F.**

Salter, Richard P., 253 West 127th Street.
Satterlee, F. Leroy, M.D., 21 W. 19th Street.
Satterlee, Livingston, 58 Cedar Street.
Schack, Frederick, 25 Park Place.
Schermerhorn, F. A., 61 University Place.
Schoeney, L., M.D., 68 East 104th Street.
Schoonmaker, W. D., 28 Warren Street.

Schultz, Carl H., 76 University Place.
Schuyler, Philip, 18 North Washington Square.
Sennett, George B., American Museum of Natural History.
Serrell, Lemuel W., 140 Nassau Street.
Shriver, Walter, 333 West 56th Street.
Sieberg, W. H. J., 158 East 124th Street.
Sloan, Samuel, 26 Exchange Place, **P.**
Smith, S. Hanbury, M.D., 309 Broadway, **F.**
Spencer, Rev. J. Selden, Tarrytown, N. Y., **F.**
Stevens, George F., M.D., 33 West 33d Street.
Stevens, Prof. W. Le Conte, Packer Institute, Brooklyn, **F.**
Stevenson, Prof. J. J., University of the City of New York, **F.**
Steward, D. Jackson, 20 Gramercy Park, **P.**
Stuyvesant, Rutherford, 246 E. 15th Street.

Taylor, Charles Fayette, M.D., 201 West 54th Street, **F.**
Taylor, Henry L., M.D., 201 West 54th Street.
Torry, James, American Museum of Natural History.
Todd, A. J., 261 Broadway.
Trotter, Alfred W., 112 East 127th Street.
Trowbridge, Prof. Wm. P., Columbia College, **F.**

Valentine, Lawson, 20 Lafayette Place.
Valentini, Philip, Ph.D., 249 West 23d Street.
Van Beuren, Fred. T., 21 West 14th Street.
Van Brunt, Cornelius, 319 East 57th Street, **F.**
Van Slyck, George W., 120 Broadway.
Vaux, Calvert, Bible House.
Vogdes, Capt. A. W., Fort Hamilton, L. I., N. Y., **F.**

Wall, John L., 338 Sixth Avenue, **F.**
Waller, Elwyn, Ph.D., Columbia College, **F**
Ward, William, 52 Broadway.
Warren, Miss Lillie E., 239 West 21st Street.
Watson, B. A., 124 York Street, Jersey City.
Weisse, Faneuil D., M.D., 51 West 22d Street, **F.**
Weld, Mrs. Amy T., 119 East 23d Street.
Weston, Henry, 31 Nassau Street, **P.**

White, James H., 14 W. 39th Street.
White, Philip A., 102 Gold Street.
Whitehouse, F. Cope (at present abroad).
Whitfield, Prof. R. P., Amer. Museum of Natural History, **F.**
Wiechmann, Fred. G., Ph.D., Columbia College, **F.**
Wiener, Joseph, M.D., 150 East 61st Street.
Wood, Isaac F., Rahway, N. J.
Wood, William H. S., 8 East 63d Street.
Woodman, Henry T., 204 East Sixth Street.
Wurtz, Prof. Henry, 2142 Seventh Avenue.

Youmans, William J., M.D., 3 Bond Street, **F.**

HONORARY MEMBERS.

(RESTRICTED TO FIFTY.)

	ELECTED
Ackerman, Prof. R., Stockholm, Sweden	1876
Agassiz, Prof. Alexander, Cambridge, Mass	1887
Bunsen, Prof. Robert, Heidelberg, Baden	1876
Candolle, Prof. Alph. de, Geneva, Switzerland	1852
Croll, Prof. James, Edinburgh, Scotland	1876
Dallinger, Rev. J. H., London, England	1887
Dana, Prof. James D., New Haven, Conn	1842
Dawkins, Prof. W. Boyd, Manchester, England	1876
Dawson, Sir William, Montreal, Canada	1876
Descloizeaux, Prof. A., Paris, France	1876
Fizeau, H. L., Paris, France	1879
Flower, Prof. W. H., London, England	1887
Frankland, Prof. Edward, London, England	1879
Geikie, Prof. Archibald, London, England	1876
Geinitz, Prof. Hans Bruno, Dresden, Saxony	1876
Hall, Prof. James, Albany, N. Y	1852
Hartlaub, Dr. Gustav, Bremen, Germany	1864
Hauer, Prof. Franz von, Vienna, Austria	1864
Helmholtz, Prof. H., Berlin, Prussia	1876
Hofmann, Prof. A. W., Berlin, Prussia	1876
Hooker, Sir Joseph D., London, England	1879
Huxley, Prof. Thos. H., London, England	1876
Joule, James P., Manchester, England	1879
Kenngott, Prof. Adolph, Zurich, Switzerland	1864
Kirchhoff, Prof. Gustavus, Berlin, Prussia	1879
Kokscharow, Prof. Nicholas von, St. Petersburg, Russia	1879
Lange, Prof. Victor von, Vienna, Austria	1876
Langley, Prof. S. P., Washington, D. C	1887
Leidy, Dr. Joseph, Philadelphia, Pa	1887

	ELECTED
Lockyer, J. Norman, London, England	1880
Muller, Baron Ferd. von, Melbourne, Australia	1887
Owen, Prof. Richard, British Museum, London, England	1879
Pasteur, Prof. Louis, Paris, France	1887
Quatrefages, Prof. J. L. A., Paris, France	1879
Rawlinson, Sir Henry Cresswicke, London, England	1882
Richter, Prof. Th., Freiberg, Saxony	1876
Roscoe, Sir Henry, Manchester, England	1887
Rosenbusch, Prof. H. F., Heidelberg, Germany	1887
Thomson, Sir William, London, England	1876
Torell, Prof. Otto, Stockholm, Sweden	1876
Tunner, Prof. P. Ritter von, Leoben, Austria	1876
Tyndall, Prof. John, London, England	1887
Young, Prof. Charles A., Princeton, N. J	1878

CORRESPONDING MEMBERS.

	ELECTED
Abbe, Prof. Cleveland, Washington, D. C.	
Abbott, Dr. Chas. C., Trenton, N. J	1883
d'Achiardi, Prof. Antonio, University of Pisa, Italy	1883
Adams, Rev. H. M., Gaboon, Africa	1854
Agassiz, Alexander, Cambridge, Mass	1866
Am Ende, Dr. C. G., Hudson City, N. J	1874
Angas, Geo. French, London, England	1864
Appleton, Prof. John H., Providence, R. I	1876
Archbald, Andrew, Paris, France	1852
Austen, Prof. Peter T., New Brunswick, N. J	1878
Ayres, Dr. W. O., New Haven, Conn	1864
Balch, Geo. T., New York, N. Y	1876
Ball, Prof. Valentine, Dublin, Ireland	1885
Barclay, Robert, England	1830
Bard, John, Tours, France	1836
Batchelder, John M., Cambridge, Mass	1854
Bayle, Prof. E., School of Mines, Paris, France	1868
Beadle, E. L., M.D., Poughkeepsie, N. Y	1835
Bechler, Lieut. W. H., Newport, R. I	1880
Bell, J. Graham, Boston, Mass	1878
Bell, James H., Sandusky, Ohio	1836
Bennet, Rev. Cephas, Tavoy, Burmah	1847
Berthoud, Edw. L., Golden City, Col	1867
Bertrand, Prof. Émile, Rue de Tournon, Paris, France	1883
Binney, W. G., Burlington, N. J	1857
Bishop, Nath. H., Lake George, N. Y	1869
Boissier, E., Geneva, Switzerland	1852
Bolles, Rev. E. C., Salem, Mass	1865
Bombicci, Prof. Luigi, University of Bologna, Italy	1883
Boni, Giacomo, Venice, Italy	1886
Brandegee, Townsend S., Cañon City, Col	1874
Branner, Prof. J. C., Little Rock, Ark	1884
Brewster, Wm., Cambridge, Mass	1874

	ELECTED
Brockett, L. P., M.D., Hartford, Conn	1847
Brown, Rev. Samuel R., S.T.D., Yokohama, Japan	1859
Brunet, Dr., Bahia, Brazil	1867
Brush, Prof. Geo. J., New Haven, Conn	1876
Buck, C. Elton, Wilmington, Del	1866
Caldwell, Prof. Geo. C., Ithaca, N. Y	1876
Carmichael, Prof. Henry, Boston, Mass	1876
Castelnau, Count, Paris, France	1839
Chandler, Prof. W. H., Bethlehem, Pa	1876
Chapman, A. W., M.D., Apalachicola, Florida	1836
Chapman, Prof. E. J., Toronto, Canada	1877
Chester, Prof. Albert H., Clinton, N. Y	1877
Christy, David, Baltimore, Md	1852
Clark, Thomas, Bristol, England	1827
Clarke, Prof. F. W., Washington, D. C	1876
Clay, Joseph A., Philadelphia, Pa	1857
Collett, Prof. John, Indianapolis, Ind	1880
Comstock, Prof. Theo. B., Champaign, Ill	1877
Cook, Prof. George H., New Brunswick, N. J	1874
Cooke, Prof. Josiah P., Jr., Cambridge, Mass	1876
Cooke, Dr. M. C., London, England	1868
Cooper, Dr. James G., Hayward, Cal	1855
Cope, Prof. Edward D., Philadelphia, Pa	1876
Cornwall, Prof. H. B., Princeton, N. J	1876
Cory, Charles B., Boston, Mass	1880
Cox, Kenyon, Anaheim, Cal	1880
Crawford, Jos. A., Davenport, Iowa	1877
Credner, Prof. Hermann, Leipsic, Saxony	1866
Crosse, H., Paris, France	1864
Dale, T. Nelson, Toronto, Canada	1879
Dall, Prof. William H., Washington, D. C	1870
Dana, Arnold Guyot, Brooklyn, N. Y	1887
Dana, Prof. Edw. S., New Haven, Conn	1885
Deane, Ruthven, Cambridge, Mass	1874
Denning, W. H., Fishkill, N. Y	1832
Divine, Dr. S. R., Lake Sheldrake, N. Y	1867
Doubleday, Edward, Epping, England	1838
Douglass, Prof. Silas H., Ann Arbor, Mich	1876
Dow, Capt. John M., New York	1869

ELECTED

Drown, Prof. Thomas M., Boston, Mass..... 1876
Drummond, Prof. Henry, Glasgow, Scotland..... 1887
Dubois, Henry A., M.D., New Haven, Conn..... 1836
Duns, Prof. John, Edinburgh, Scotland..... 1868

Eaton, Prof. Daniel C., New Haven, Conn..... 1860
Edsall, Burroughs, Spuyten Duyvel, N. Y..... 1884
Edwards, Dr. Arthur M., Newark, N. J..... 1873
Elliot, Daniel G., New York City..... 1860
Elliot, Henry W., Washington, D. C..... 1876
Elliott, Prof. John B., Sewanee, Tenn..... 1880
Engelhardt, Dr. Francis E., Syracuse, N. Y..... 1869
Ernst, Dr. Adolfo, Caracas, Venezuela..... 1878

Fairbank, Rev. W., East Indies..... 1853
Fairchild, Prof. H. Le Roy, Rochester, N. Y..... 1879
Fay, H. F., Columbus, Ohio..... 1858
Fenzi, Cav. Sebastiano, Florence, Italy..... 1887
Fisher, Geo. Jackson, M.D., Sing Sing, N. Y..... 1845
Fittica, Prof. F., University of Marburg, Germany..... 1879
Fletcher, Prof. Lazarus, London, England..... 1885
Ford, Prof. Darius R., Elmira, N. Y..... 1874
Ford, Silas W., Schodack Landing, N. Y..... 1873
Fresenius, Prof. C. R., Wiesbaden, Germany..... 1879
Fritz-Gaertner, Dr. R., Tegucigalpa, Honduras..... 1879

Gadolin, Gen. Alex., St. Petersburg, Russia..... 1868
Gaussoin, E., Baltimore, Md..... 1867
Gibbs, Prof. Wolcott, Cambridge, Mass..... 1840
Gilbert, G. K., Washington, D. C..... 1870
Gill, Dr. Theodore, Washington, D. C..... 1858
Gilman, Pres. D. C., Baltimore, Md..... 1876
Girard, Charles, Paris, France..... 1852
Goessman, Prof. C. A., Amherst, Mass..... 1865
Gooch, Prof. F. Austin, New Haven, Conn..... 1888
Goode, Prof. G. Brown, Washington, D. C..... 1876
Gordon, Dr. Antonio de, Havana, Cuba..... 1883
Grattarola, Prof. Giuseppe, Florence, Italy..... 1883
Gravenhorst, J. H. Waters, Bonaire, W. I..... 1882
Green, S. F., Jaffna, Ceylon..... 1867
Greenleaf, R. C., Boston, Mass..... 1868
Gregg, Dr. Wm. H., Elmira, N. Y..... 1865

	ELECTED
Gregorio, Marchese Antonio di, Palermo, Sicily	1883
Grierson, T. M. D., Dumfriesshire, Scotland	1865
Grote, Prof. Aug. R., Buffalo, N. Y	1876
Groth, Prof. Paul, University of Strassburg, Germany	1877
Gunning, Thos. B	1878
Guppy, R. J. L., Trinidad, W. I	1869
Hagen, Dr. Herman A., Cambridge, Mass	1874
Hague, James D., New York, N. Y	1874
Hamlin, Chas. E., Waterville, Maine	1865
Hancock, D., Demerara, W. I	1824
Hanley, Sylvanus, London, England	1864
Hardin, M. B., Lexington, Va	1866
Hartman, W. D., M.D., West Chester, Pa	1852
Hawkins, B. Waterhouse, London, England	1868
Hayes, S. Dana, Boston, Mass	1876
Henry, Charlton F., U.S.A	1853
Henwood, W. Jory, Cornwall, England	1842
Hepburn, J. M., M.D., Japan	1859
Hesse-Wartegg, Count Ernst von, New York	1882
Hexamer, Dr. F. M., New Rochelle, N. Y	1857
Hickock, W. C., Vermont	1848
Hidden, Wm. Earl, Newark, N. J	1875
Hill, Prof. Henry B., Cambridge, Mass	1876
Himes, Prof. Charles F., Carlisle, Pa	1876
Hitchcock, Prof. Charles H., Hanover, N. H	1867
Horsford, Prof. E. N., Cambridge, Mass	1876
Horton, Letas R., Goshen, N. Y	1864
Howard, Thos. T., Jr., Perth Amboy, N. J	1877
Hunt, Dr. T. Sterry, Boston, Mass	1867
Hyatt, Prof. Alpheus, Cambridge, Mass	1876
Hyatt, Prof. James, Stanfordville, N. Y	1876
Iles, Malvern W., Denver, Col	1875
James, Major O. C., Rio Janeiro, Brazil	1867
Jamieson, Rev. J. M., Sabatha, India	1847
Jannetaz, Prof. A., College Sorbonne, Paris, France	1883
Jesup, Rev. Henry Griswold, Hanover, N. H	1885
Johnson, Prof. Sam'l W., New Haven, Conn	1876
Jordan, Pres. David S., Bloomington, Ind	1876

ELECTED

Joy, Prof. Charles A., Munich, Germany.... 1878
Judd, Orange, Middletown, Conn.... 1876

Kelley, William.... 1876
Kellicott, D. S., Buffalo, N. Y.... 1886
Kendrick, Prof. H. L., U.S.M.A., West Point, N. Y.... 1876
King, C. R., M.D., Philadelphia, Pa.... 1838
King, Prof. William, Glenoir, Galway, Ireland.... 1884
Kinney, Prof. J. R., Honolulu, Sandwich Islands.... 1867
Knowlton, W. J., Boston, Mass.... 1880
Koenig, Prof. George A., Philadelphia, Pa.... 1876
Koltzoff-Massalsky, Princesse Hélène, Florence, Italy.... 1887
Koschkull, H. von, Tiflis, Caucasus.... 1868
Krebs, H. J., Copenhagen, Denmark.... 1867
Kuki, R., Tokio, Japan.... 1888
Kurtz, J. D., U.S.A.... 1865

Lacerda, Antonio de, Bahia, Brazil.... 1867
Land, Wm. J., Atlanta, Ga.... 1877
Langley, Prof. J. W., Ann Arbor, Mich.... 1876
Lattimore, Prof. S. A., Rochester, N. Y.... 1876
Lauderdale, J. V., M.D., U.S.A.... 1867
Lea, M. Carey, Philadelphia, Pa.... 1876
Le Conte, Prof. John, Berkeley, Cal.... 1876
Le Conte, Prof. Joseph, Berkeley, Cal.... 1876
Le Jolis, Dr. Auguste, Cherbourg, France.... 1876
Le Mercier, Dr. F. G., Paris, France.... 1869
Lintner, Prof. J. A., Albany, N. Y.... 1872
Lockwood, Rev. Samuel, Freehold, N. J.... 1865
Lord, Henry B., Ithaca, N. Y.... 1868
Lowe, Edward J., Nottingham, England.... 1857
Lupton, Prof. N. T., Nashville, Tenn.... 1876

Mackie, Simon F., Salt Lake City, Utah.... 1869
Macloskie, Prof. George, Princeton, N. J.... 1876
Mallet, Prof. John W., University of Virginia, Va.... 1876
Marcy, Prof. Oliver, N. W. University, Evanston, Ill.... 1871
Marsh, Prof. O. C., New Haven, Conn.... 1867
Mason, Rev. Francis, Tavoy, Burmah.... 1844
Matthew, Prof. George F., St. John, N. B.... 1867
Maynard, C. J., Boston, Mass.... 1874

	ELECTED
McChesney, Prof. J. H., Chicago, Ill	1863
McCormick, Richard H., Arizona	1869
McMurtrie, W. C., M.D., Washington, D. C	1876
Mead, Theodore L., Eustis, Florida	1874
Meek, Prof. Seth E., Cedar Rapids, Iowa	1888
Meneghini, Prof. G., Pisa, Italy	1888
Merrick, Prof. J. M., Boston, Mass	1876
Merriam, Prof. C. Hart, Washington, D. C	1874
Metcalfe, William, London, England	1842
Michie, Prof. P. S., West Point, N. Y	1885
Minot, Dr. Charles S., Boston, Mass	1878
Mixter, Prof. Wm. G., New Haven, Conn	1876
Moore, Whitby E., Para, Brazil	1844
Morch, Otto, Copenhagen, Denmark	1864
Morong, Rev. Thomas, Ashland, Mass	1888
Morris, W. W., U.S.A	1851
Morse, Prof. Edward S., Salem, Mass	1864
Mortimer, Capt. John H., New York	1875
Nason, Prof. Henry B., Troy, N. Y	1876
Nevius, Rev. Reuben D., Baker City, Oregon	1867
Newcombe, Wesley, M.D., Ithaca, N. Y	1835
Newton, Prof. Alfred, Cambridge, England	1866
Nicholls, Dr. H. A. Alford, Dominica, W. I	1882
Nicolis, Sig. Cav. Enrico, Verona, Italy	1884
Niles, Prof. Wm. H., Boston, Mass	1881
Nolan, Dr. Edward J., Philadelphia, Pa	1880
Nordenskjöld, Prof. N. A. E., Stockholm, Sweden	1868
Ober, Frederick A., Beverly, Mass	1879
Oothout, Henry, Stamford, Conn	1865
Ordway, Prof. John M., New Orleans, La	1876
Orton, Prof. Edward, Columbus, Ohio	1871
Ostensacken, Baron R., St. Petersburg, Russia	1857
Packard, Prof. A. S., Jr., Providence, R. I	1866
Packard, R. L., Washington, D. C	1877
Paine, Prof. John A., Tarrytown, N. Y	1877
Palmer, F. Temple, Versailles, France	1836
Parrot, Rev. Dr. J. W., Addison, Steuben County, N. Y	1869
Pecchioli, V., Pisa, Italy	1846
Peck, Thomas M., Grand Rapids, Mich	1853

	ELECTED
Peckham, Prof. S. F., Akron, Ohio	1876
Perkins, Prof. Maurice F., Schenectady, N. Y	1876
Phené, Dr. J. S., London, England	1882
Pickering, Prof. Ed. C., Cambridge, Mass	1876
Piddington, Henry, Calcutta, India	1846
Pisani, F., 8 Rue Furstenburg, Paris, France	1883
Poey, Prof. Andreas, Paris, France	1869
Poey, Prof. Felipe, Havana, Cuba	1851
Post, Prof. George E., Beirut, Syria	1888
Post, Rev. R. P., Honolulu, Sandwich Islands	1867
Potter, Prof. W. B., Washington University, St. Louis, Mo	1871
Prescott, Prof. Albert B., Ann Arbor, Mich	1876
Prime, Prof. Frederick, Jr., Easton, Pa	1877
Pumpelly, Prof. Raphael, Newport, R. I	1868
Purdie, H. A., Boston, Mass	1874
Putnam, Prof. F. W., Salem, Mass	1860
Pynchon, Prof. Th. R., Hartford, Conn	1876
Quesneville, M. le Dr., Paris, France	1879
Ramsey, J. G., M.D., Tennessee	1860
Randall, F. A., Warren, Pa	1876
Rawson, Sir Rawson W., London, England	1867
Read, Matthew C., Hudson, Ohio	1876
Reade, T. Mellard, C.E., Liverpool, England	1888
Redfield, John H., Philadelphia, Pa	1836
Remsen, Prof. Ira, Baltimore, Md	1876
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Saussure, H. de, Geneva, Switzerland	1856
Schaeffer, Prof. C. A., Ithaca, N. Y	1876
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Sclater, Philip L., London, England	1856

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HOYT, G.,
LEGGETT, SAMUEL,
PRIME, NATHANIEL,
REED, LUMAN.

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